



PROJECT MANUAL



Yukon University Polaris Project

Revised and Reissued for Addendum

Project No: 144214760
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As issued by Construction manager

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1. GENERAL

1.1 Summary Of Work

- .1 New Construction of the Yukon University Polaris Project; as detailed on Drawings and Specifications.

1.2 Project Coordination

- .1 Coordinate progress of the Work, progress schedules, submittals, use of site, temporary utilities, construction facilities and temporary controls.
- .2 All Contract Documents are written to the Construction Manager; and then to the Subcontractors. What is required by the Construction Manager is also required by all subcontractors that enter into contract with the Construction Manager. The Construction Manager will decide who is responsible for each item; if something is not clear; ask in writing for clarification.

1.3 Specification Explanation

- .1 Notice is hereby given that these Contract Documents have been prepared by the Consultant pursuant to his contract with his client. The Contract Documents may contain limitations or errors which may not be evident. Their accuracy is not warranted. Any person, other than the Owner, using or relying on these Contract Documents may do so only upon the condition that its' rights to make any claim whatsoever, which may arise from its' use of these Contract Documents, are limited solely to the contractual rights which it may have against the person who provided the Contract Documents to it pursuant to its' Contract. It further agrees that it has no rights whatsoever to claim damages from the Consultant resulting from the use of these Contract Documents.
- .2 Parts of the specification are written in short form, therefore, it is understood that where a component of the work is stated in a heading followed by a material or operation, the words "shall be", "shall consist of", or similar words or phrases are implied which denote complete supply and installation of such materials or operations for the component of work designated by the heading.
- .3 Wherever a standard confers upon a person, body politic or a body corporate, the right to approve, to select, exercise authority or to interpret the standard, and refers to that person, body politic or body corporate as the Engineer, Owner, Construction Manager or by some other such designation, the Consultant has the right to exercise the powers of any such person, body politic or body corporate.

1.4 Professional Design & Review Schedules

- .1 In conformance with Division C, article 2.4 of the National Building Code, all Subcontractors for architectural work, who are required to provide shop drawings signed and sealed by a professional engineer registered in the Yukon Territory, must agree to sign Schedules B, C2 and C3, which are included in article 2.4 of the National Building Code. Subcontractors must provide a letter with the Bid, indicating acceptance of this requirement, or they will be rejected. This requirement will be strictly enforced.

1.5 Definitions

- .1 Where a standard designates authorities such as the "Engineer", "Owner", (when used in a sense other than that defined in the General Conditions) or some other such designation, these designations mean the Consultant; the Architect is the Prime Consultant. The Architect is Stantec Architecture.
- .2 The "Construction Manager" is as defined in Owner/Contractor agreement: Ketz Construction Ltd.
- .3 In the specifications, references such as "indicated on the drawings", "specified", "scheduled", "called for", as similar phrases, include work required by the Contract Documents.

- .4 The term "Section Includes" identifies the general work scope which the Section covers, and also itemizes particular elements of work which could have been located in some other Section.
 - .5 The term "Related Sections" lists Sections which could be associated with the work covered by the Section and are highlighted as a guide only for ease of reference. All Sections of the specifications are related to each other, whether listed under "Related Sections" or not.
 - .6 The expression "provide" includes the provision, installation and finishing, maintenance, servicing and removal of the work described. Repair and make good all work damaged by temporary installations, at no extra cost to the Owner.
 - .7 Unless the word "only" suffixes "supply" or "install" or other variation of those words according to the Contract wherein they are used, it is the express intent of this Contract that "supply and install" is implied. Unless otherwise specified, install Work in accordance with the manufacturer's printed directions and recommendations.
 - .1 The term "Supply Only" means the procurement or fabrication of materials, equipment, or components, or the performance of services to the extent indicated. Where used with respect to materials, equipment or components, the terms include delivery to the Place of Work but is not intended to include the installation of the item, either temporary or final.
 - .2 The term "Install Only" means the placement of materials, equipment or components, including the receiving, unloading, transporting, storage and installing and the performance of such testing and finish work as is compatible with the degree of installation specified.
 - .8 An "Approved Method" or "Accepted Method" means that which has the manufacturer's recommendation or which is generally accepted as good trade practice. The Consultant's acceptance is also required.
 - .9 The term "Consultant's Reviews" mean a general review only by the Consultant, not a detailed inspection of all the Work.
 - .10 The term "work site" means the total site within the property lines as indicated on the site plan.
 - .11 The term "preapproved product" means preapproved five (5) working days prior to closing of Subtrade Bids.
 - .12 "Approve/Approval/Preapproved/Certified/Verified", when any of these terms are used in the Contract Documents with respect to an action by the Consultant, they shall mean reviewed by the Consultant without exceptions.
 - .13 The term "As Indicated" means as indicated on the Drawings which accompany these Specifications, both of which are part of the Contract Documents.
 - .14 The term "As Specified" means collectively all terms, requirements, stipulations etc, as described for the respective equipment, material or method in the Specifications forming part of the Contract Documents.
- 1.6 Construction Manager's Responsibilities
- .1 The Construction Manager assumes total control of the Work and will effectively direct and supervise the Work so as to ensure conformity with the Contract Documents.
 - .2 The Construction Manager is solely responsible for construction means, methods, techniques, sequencing, safety, scheduling, and procedures and for coordinating the various parts of the Work.
 - .3 This Section is written for the purpose of obtaining Bids by the Construction Manager from Subcontractors, and do not relieve the Construction Manager from responsibility for overall coordination. The individual specification Sections do not necessarily define trade scope, and it is the Construction Manager's responsibility to determine each Subcontractor's trade scope.

- .4 The Construction Manager is responsible for all coordination for the Project, including coordinating Subcontractors, and for ensuring that the Contract between the Construction Manager and the Owner and Contracts between the Construction Manager and Subcontractors are coordinated and adhered to.
- .5 If items in this specification are noted as being done by the Subcontractor, it does not relieve the Construction Manager from his responsibilities to coordinate such Work and to ensure such items are done in accordance with the Contract Documents and done within time allotted in the agreed upon schedule. Items noted as being done by the Subcontractor may be done by the Construction Manager, if it is deemed to best suit the Work of this Contract. Where items are noted as being done by Subcontractors, the Construction Manager is also responsible for such items.
- .6 In the case of a dispute, the Construction Manager and Prime Consultant arbitrate disputes regarding trade scope. Extras will not be considered on the grounds of differences in interpretation of the Specification as to which Sub-Contractor does which work.
- .7 The Construction Manager will provide full-time site administration to ensure that all Subcontractors coordinate their work with Other Subcontractors and to ensure that the established construction schedule is maintained.
- .8 Each Subcontractor shall cooperate fully with the Construction Manager and with all other Subcontractors.
- .9 Any Subcontractor who considers that there is a lack of cooperation on the part of any Other Subcontractor shall promptly so inform the Construction Manager in writing.
- .10 When work is being done on site, the Construction Manager will be on site continuously during the work, weather and site conditions permitting.

2. PROJECT CO-ORDINATION

2.1 Site Examination

- .1 Examine the field conditions and determine if any conflicts arise between the Construction Documents and the required construction sequence. Inform the Consultant in writing immediately, should a conflict arise.
- .2 Submission of a Subtrade Bid is deemed to be evidence that the Subcontractor has examined the site and is familiar with conditions under which work will be done.
- .3 If, while carrying out the Work, conditions are exposed which are in contravention with applicable regulatory codes and requirements of authorities having jurisdiction, unsafe or in any way less than the acceptable industry standard for the particular item, immediately notify the Consultant before proceeding with further work. The Consultant will review the condition and issue the appropriate instruction.

2.2 Co-ordination

- .1 Coordinate the progress of the Work, progress schedules, submittals, use of the site, temporary utilities, construction facilities and controls.
- .2 Co-ordinate work of all trades and Subcontractors to expedite progress and avoid interference. This applies particularly to work of trades which will be installed in close proximity with work of other trades.
- .3 Coordinate installation of all utilities, including Electrical, telephone, cable TV, gas, water, sewer, sanitary and the like. Construction Manager to have utilities (excluding natural gas and electrical) in their name until Substantial Performance of the Work, at which point utilities will be placed in the Owner's name. Construction Manager responsible for hook-up to main service.
- .4 Notify trades and Subcontractors of readiness for their Work, to allow adequate time for installation without delaying completion of project.

- .5 Bring to the attention of the Consultant all discrepancies between Contract Documents and existing and surrounding site conditions and all other discrepancies. Do not proceed until course of action has been established by the Consultant. Failure to do so, in no way relieves the Subcontractor from responsibility to performing the work as intended, at no additional cost to the Owner.
- .6 Supply all items to be built in including anchors, ties, nailing strips, blocks, bolts, sleeves, etc., as and when required, together with templates, measurements and shop drawings.
- .7 Establish correct location of sleeves, inserts, hangers, holes and chases.
- .8 Check and verify dimensions as the Work proceeds.

2.3 Diagrammatic Locations

- .1 Undimensioned locations of equipment, fixtures and outlets indicated or specified are to be considered as approximate. Confirm all undimensioned locations including location of electrical, security and communications fixtures, outlets and switches, mechanical grilles and all other such items, prior to installation.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Note furring requirements and limitations indicated on the drawings. Make allowances for possibility that indications and locations on mechanical and electrical drawings are diagrammatic.
- .4 Where locations of holes in the structure would possibly affect the nature or strength of structure, inform the Consultant before proceeding. Clearly dimension locations on shop drawings submitted for review.
- .5 Inform Consultant of impending installation of items of Work which are diagrammatically indicated on the drawings, and obtain acceptance for actual location.
- .6 Submit field drawings to indicate relative position of various services and equipment when required by Consultant.

2.4 Working Limits

- .1 Confine all operations within the designated work area.
- .2 Co-ordinate access routes to the work area with the Owner.

2.5 Smoking

- .1 Smoking or vaping is NOT permitted within the building, designated areas will be established by Construction Manager in conjunction with Owner's approval.
- .2 Conform to Owner's and all other regulatory requirements regarding smoking on or near the site.

2.6 Harassment

- .1 For the purpose of this Contract, follow the harassment guidelines specified herein to prevent conduct defined as harassment, between the Construction Manager, Subcontractors, Sub-Subcontractors, the Owner and the Consultants.
- .2 Harassment is defined as unwanted attention, in verbal, written, graphic or physical form and any such conduct which creates an offensive or intimidating working environment.
- .3 For the purposes of these guidelines, all site shacks, offices, and general site will be considered to be "public" spaces. Remove such material, either written or graphic, on view in "public" spaces, deemed to be offensive by the Consultant or Owner.

- .4 Any conduct considered as harassment will be brought to the attention of the Construction Manager. The Construction Manager will be responsible to prevent further incidents.
 - .5 Ensure that all employees, including, Subcontractors and Sub-Subcontractors working on the construction site are familiar with and adhere to these guidelines.
- 2.7 Responsible Personnel
- .1 Throughout the course of construction, the Construction Manager, mechanical Subcontractor, electrical Subcontractor and all other such Subcontractors as deemed appropriate for the stage of construction, must designate and advise the Owner of a contact person and back-up contact person for working hours and non-working hours in the event of emergencies. Ensure 24 hour emergency contact, to the contact person, utilizing a cellular phone.
- 2.8 Publicity
- .1 All publicity relating to this project is subject to the approval of the Owner.
 - .2 No mention of the Project in advertising or articles in any publication will be permitted unless accepted by the Owner.
 - .3 Publicity or advertising implying endorsement of a product by the Owner will not be permitted.
- 3. CUTTING AND PATCHING**
- 3.1 General
- .1 Should cutting and patching be required, the following will apply.
- 3.2 Acceptances
- .1 Submit written request in advance of cutting or alteration other than that indicated in the Contract Documents which affects the following:
 - .1 Structural integrity of any element of the Project,
 - .2 Integrity of weather-exposed or moisture-resistant elements,
 - .3 Efficiency, maintenance, or safety of any operational elements,
 - .4 Visual qualities of sight-exposed elements, or
 - .5 Work of Owner or separate Contractor.
- 3.3 Inspection
- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
 - .2 Prior to coring or cutting holes in any existing slabs on grade, x-ray area where core is to be taken. If proposed core or hole locations occur mechanical and/or electrical lines or services, conduit or piping, move cores or holes in another location as accepted by the Consultant.
 - .3 After uncovering, inspect conditions affecting performance of Work.
 - .4 Check and mark all mechanical and electrical installations in areas which may be affected by concrete cutting.
 - .5 Beginning of cutting or patching means acceptance of existing conditions.
 - .6 Do not cover up work, especially mechanical and electrical work, until it has been reviewed and accepted by the Consultant.
- 3.4 Execution
- .1 Perform cutting, fitting, and patching including excavation and fill, to complete the Work.

- .2 Remove and replace defective and non-conforming work.
- .3 Provide openings in non-structural elements of Work for penetrations of Mechanical and Electrical work.
- .4 Perform work to avoid damage to other work.
- .5 Prepare surfaces to receive patching and finishing.
- .6 Employ qualified installer to perform cutting and patching for weather exposed and moisture resistant elements, and site exposed surfaces.
- .7 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.
- .8 Do not oversize holes.
- .9 Restore work with new products in accordance with the Contract Documents.
- .10 Fit work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .11 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with fire-rated material, specified in Section 07 84 00, full thickness of the construction element, to the satisfaction of the Authority Having Jurisdiction.
- .12 Ensure that waterproofing and roofing is protected and that no waterproofing or roofing or seals are cut or destroyed by any Subcontractor. Where waterproofing or roofing or seals must be cut or damaged to facilitate installation of work ensure that waterproofing, roofing and seals are immediately repaired and made watertight, using the qualified installer and materials and installation methods to match original work.
- .13 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection. For an assembly, refinish entire unit.
- .14 Making good is in general defined as matching the adjacent surfaces such that there be no visible difference between existing and new surfaces when viewed in ambient light. In renovation areas making good means repairing the substrate surfaces and in existing areas not being renovated, refers to finishing to match adjacent surfaces and includes applying a new paint finish to the surface up to the next change in plane.
- .15 At all penetrations through acoustically treated wall and partition assemblies, completely seal all penetrations with acoustic sealant, tape and insulation as required to prevent sound transfer and to maintain the required STC rating of wall.

4. SITE ENGINEERING

4.1 Qualifications of Surveyor

- .1 Qualified registered land surveyor, acceptable to Owner and Construction Manager.
- .2 Locate, confirm and protect control points prior to starting site work. Preserve permanent reference points during construction.
- .3 Protect and pressure control and reference points during construction.

4.2 Layout Requirements

- .1 Establish lines and levels, locate and layout, by instrumentation.
- .2 Verify all lines, levels, datum, and dimensions as shown on the drawings, and report errors or inconsistencies in the above to the Consultant before commencing work. Failure to do so does not relieve the Contractor from the responsibility of correcting same.

- .3 Correctly lay out Work to lines and levels in accordance with the drawings; in all cases figured dimensions are to be followed rather than those scaled from the drawings.
- .4 Exercise every possible precaution to verify the figures shown on the drawings and to obtain from the Consultant any additional dimensions or information he may require before laying out the work. Be responsible for rectifying any errors or incorrect work due to his failure to exercise such precautions.
- .5 Examine surfaces on, to or against which work is to go to ensure that same are square, true, level, plumb, or correct shape, etc., or in the proper condition to receive such new work. Should any surface not be suitable notify the Consultant, otherwise replace in an acceptable manner, any or all work as directed to correct any defects which may occur.

4.3 Subsurface Conditions

- .1 Promptly notify the Consultant in writing if subsurface conditions at the place of the Work differ materially from those indicated in the Contract Documents, or a reasonable assumption of probable conditions based thereon.

4.4 Records

- .1 Maintain a complete, accurate log of control and survey work as it progresses.

5. PROJECT MEETINGS

5.1 Administrative

- .1 Construction Manager will schedule and administer project progress meetings throughout the progress of the Work on a bi-weekly basis (every two weeks) plus and as required. Subcontractors are required to attend progress meetings to properly coordinate the Work. Construction Manager will invite Subcontractors as required for coordinating the Work.
- .2 If a change to the regularly scheduled meeting is required, distribute written notice to all representatives, three days in advance of the meeting date.
- .3 Construction Manager will prepare agenda for meetings.
- .4 Construction Manager will distribute written notice of each meeting five (5) days in advance of meeting date to the Consultant, the Owner's representative, Subcontractors and/or other persons whose presence is required.
- .5 Construction Manager will provide physical space and make arrangements for meetings.
- .6 The Construction Manager will record the summary. The Construction Manager will include significant proceedings and decisions. Identify parties requiring action in right column of minute page. The Construction Manager will indicate the following:
 - .1 List of persons attending.
 - .2 Decisions taken.
 - .3 Instructions required or issued.
 - .4 All matters discussed.
- .7 The Construction Manager, with 48 hours of meeting, will type, reproduce and distribute copies of summary after each meeting and transmit to meeting participants, affected parties not in attendance and the Owner.
- .8 The site meetings and site office are to be designated as "NO SMOKING" zones.
- .9 Conduct subtrade meetings on a weekly basis, and distribute summary to all affected parties.

5.2 Pre-Construction Meeting

- .1 Within one week after award of the Contract, the Consultant will request a meeting to discuss and resolve administrative procedures and responsibilities.
- .2 Ensure representatives of the Owner, Consultant, Construction Manager and major Subcontractors are in attendance.
- .3 Establish time and location of meeting and notify all parties concerned to attend. Notify parties minimum five (5) days before meeting.

5.3 Progress Meetings

- .1 After award of Contract, Construction Manager will arrange progress meetings bi-weekly (every two weeks) at agreed times. Notify all parties concerned, including major Subcontractors, Consultant and Owner to attend, to ensure proper co-ordination of Work.
- .2 Construction Manager will submit full and completely itemized Construction Schedule showing stages of all units of Work including dates for shop drawing review, up to completion of Work after draft Progress Schedule is reviewed by Consultant.
- .3 Construction Manager will include intermediate dates for specific portions of Work to be completed for Owner's use and dates for receiving and installing any Owner purchased or supplied equipment.
- .4 Do not change Schedule without Consultant's written acceptance. Where change is necessary, submit written reasons for the change to Consultant for review and comment.
- .5 Indicate actual progress relative to Progress Schedule as part of Progress Claim.

5.4 Warranty Meetings

- .1 Construction Manager will Hold Warranty Meetings between Substantial Performance of the Work and just prior to the one year anniversary of Substantial Performance of the Work.
- .2 Purpose: to bring to the Contractor's attention Contract Deficiencies identified during warranty period, determine action required for their correction, and monitor progress of the Contract Deficiency correction.
- .3 Frequency: called by the Consultant on an as-needed basis.
- .4 Location: as agreed to between the Consultant and Construction Manager.
- .5 Attendees: same as construction progress meetings.
- .6 Summary: same as construction progress meetings.
- .7 Agenda:
 - .1 Review and acceptance of summary of previous meeting.
 - .2 Review of progress of Contract Deficiency correction.
 - .3 Identification of problems impeding Contract Deficiency correction.
 - .4 Review of outstanding Contract Deficiencies.
 - .5 Other Business.

6. SUBMITTALS

6.1 Submittals - General

- .1 Where multiple documents are submitted to Consultant, indicate in Submittals Schedule priority for each item. Consultant will endeavor to meet return date criteria.

- .2 Submit to the Consultant submittals listed for review in accordance with the reviewed submittals schedule. Failure to submit in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.
 - .1 Do not proceed with Work affected by the submittal until review is complete.
 - .2 Review submittals prior to submission to Consultant. Review by the Construction Manager. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with the requirements of the Work and the Contract Documents. Submittals not stamped, signed, dated and identified as to the specific project will be returned without being examined and will be considered rejected.
 - .3 All submittals must bear the stamp of the Construction Manager and Subcontractor prior to submitting. Submittals which do not bear the stamp of the Construction Manager, will be rejected.
 - .4 Review of Shop Drawings by the Consultant is for the sole purpose of ascertaining conformance with the general design concept and for general arrangement only. This review does not mean approval of the detail design inherent in the Shop Drawings, responsibility for which remains with the Construction Manager submitting same. Such review does not relieve responsibility for errors, omissions or deviations in Shop Drawings or samples or of responsibility for meeting all requirements of the Contract Documents, unless a deviation has been accepted in writing by the Consultant.
 - .5 Accompany submittals with transmittal letter, in duplicate, containing:
 - .1 Date
 - .2 Project title and number.
 - .3 Construction Manager's name and address.
 - .4 Number of each Shop Drawing, project datum and samples submitted.
 - .5 Other pertinent data.
 - .6 Include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Applicable name of:
 - Construction Manager
 - Sub-contractor
 - Supplier
 - Manufacturer
 - Separate details when pertinent
 - .7 Identification of project or materials.
 - .8 Relation to adjacent structure or materials.
 - .9 Field dimensions, clearly identified as such.
 - .10 Specification Section number.
 - .11 Applicable standards, such as CSA or CGSB numbers.
 - .12 Construction Manager's stamp, certifying the review of submittal, verification of field measurements and compliance with the Contract Documents.
- .3 Verify field measurements and affected adjacent Work are coordinated.
- .4 Keep one reviewed copy of each submission on site.
- .5 Identify clearly on all submissions any deviation from the Contract Documents.
- .6 Present shop drawings, product data, samples and mock-ups in same units as Drawings.
- .7 Where items or information is not produced in SI Metric units converted values are acceptable.
- .8 Notify in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .9 Shop Drawings or Submittals submitted to the Consultant with the words "By Others" will be rejected. Construction Manager to fill in who is responsible.

6.2 Electronic Drawing Files

- .1 Electronic drawing files in CADD format or REVIT (rvt) format at no cost, may be available to aid in the production of Shop Drawings specific to this Project. The Consultant will not be held responsible for Shop Drawings produced from CADD provided to the Construction Manager or Subcontractors. Release of CADD of Contract Documents, is for the sole purpose of producing Shop Drawings for this project and is not a waiver of Copy Right. Electronic Drawing Files: subject to the following conditions:
 - .1 The Consultant to review the electronic drawing files requested And provide an Electronic Document Transfer Agreement for signature prior to release of files.
 - .2 Electronic drawing files will be provided by e-mail or FTP site, depending on size and quantities of requested electronic drawing files.
 - .3 Electronic drawing files will be provided in the CADD file format or REVIT in which electronic drawing files were produced. A change to the version or format will not be undertaken by the Consultant.
 - .4 Consultant makes no warranty or guarantee that dimensions provided or established from the electronic drawing files represent actual site conditions.
 - .5 Construction Manager remains responsible for establishing and confirming field dimensions and project conditions, and providing this information to affected Subcontractors, except as limited below.
 - .6 In the event that there is a discrepancy between the electronic drawing files provided and the Bid Documents and Addenda, the Bid Documents and Addenda govern.
 - .7 In the event that dimensions are not indicated, do not electronically scale from the electronic drawing files. Where dimensions are missing, bring to the attention of the Consultant, who will determine the dimensions or direct the method for determination of the missing dimensions.
 - .8 Construction Manager and Subcontractors must recognize that use of the electronic drawing files is at their own risk. The Construction Manager and Subcontractors will be required to sign an agreement accepting terms of use including, but not limited to, the following:
 - .9 Construction Manager, Subcontractor, Sub-Subcontractor, supplier, manufacturer, or other third party agent agrees to indemnify and hold harmless the Consultant and Owner from any damage, liability or costs arising from the use of the electronic drawing files conveyed in the CADD file format provided.
 - .10 Consultant retains the copyright for electronic drawing files.
 - .11 Use of the supplied electronic drawing files for any subsequent Project is strictly forbidden without the express written consent of the Consultant.
 - .12 Consultant and Owner will not be held liable of any unauthorized use of modification of the electronic drawing files provided.
 - .13 Consultant expressly disclaims any warranty or assurance that electronic drawing files will remain accurate beyond the date that the files were created.
 - .14 The Consultant and Owner assumes no responsibility and disclaims any liability to any person or entity for any loss or damages including any special, indirect or consequential damages caused by error or omissions in the electronic drawing files and CADD format provided, whether resulting from negligence, accident or any other cause.
- .2 The Consultant will alter electronic drawing file information not essential to the Contract from materials provided to the Construction Manager including, but not limited to, the following:
 - .1 Remove Title Blocks and Logos.
 - .2 Remove Professional Seals.
 - .3 Bind External Files and Blocks.
- .3 Consultant reserves the right to withdraw the offer for electronic drawing files.
- .4 Consultant reserves the right to reject Shop Drawings prepared from electronic drawing files that have not been substantially altered from the electronic drawing files provided, and as follows:
 - .1 Shop Drawings do not reflect constructability requirements.
 - .2 Shop Drawings are not detailed in accordance with requirements listed in the technical Specification Sections.

- .5 Any proposed deviations from the Contract Documents must be boldly indicated as such on the Shop Drawings. No acceptance is inferred or assumed otherwise.
- .6 Each Subcontractor or Supplier requesting electronic drawing files must fill in Electronic Document Transfer Agreement form prior to release of any documents. Contact Consultant for a copy of this form.
- 6.3 Construction Manager's Registered Professional Engineer's Requirements
 - .1 Refer to Section 01 33 50.
- 6.4 Seismic Design and Requirements
 - .1 Design components of the Building, as applicable, and comply with requirements of jurisdictional authorities.
- 6.5 Building Permit Submittal Requirements
 - .1 If required, submit technical information, test results, ITS (Intertek Testing Services - Warnock Hersey), ULC, ULI and other acceptable fire rating systems, to the authority having jurisdiction, as required to obtain release of the Building Permit. Such information will be required for fire rated items, including, but not limited to gypsum board assemblies, masonry assemblies, sprayed fireproofing, fire stop and smoke seal, exterior cladding (where applicable), interior coatings, intumescent paints and varnishes, and all other items and systems which are fire rated and which require back-up data acceptable to the authority having jurisdiction, in order to obtain the Building Permit.
- 6.6 Shop Drawings
 - .1 Identification:
 - .1 Mark drawings with name of project and the Consultant's project number, specification Section number, drawing detail and sheet number referenced where subject of Shop Drawing is described and shown, and date Shop Drawing was prepared and/or revised.
 - .2 Where coordination requirements necessitate scope of Shop Drawing to include more than one item, label Shop Drawings with specification Section number of dominant trade involved. "Dominant" means greatest quantity, greatest cost, or principal detail subject of drawing, whichever may be appropriate.
 - .2 Do not base Shop Drawings of reproductions of the Contract Documents except as allowed by the use of electronic drawing files noted above.
 - .3 Shop Drawings augment, but do not supersede the Contract Documents. Review of Shop Drawings does not imply acceptance of Work.
 - .4 Any proposed deviations from the Contract Documents must be boldly indicated as such on the Shop Drawings. No acceptance is inferred or assumed otherwise.
 - .5 Submit Shop Drawings for each requirement requested in specification Sections and as the Consultant may reasonably request.
 - .6 Submit digital PDF copies of Shop Drawings for each requirement requested in the Specification Sections and as the Consultant may require. Where PDF files are submitted for Shop Drawings, prints of Shop Drawings will still be required for operation and maintenance manuals.
 - .7 Submit digital PDF copies of product data sheets or brochures for requirements requested in the specifications Sections and as the Consultant may reasonably request where Shop Drawings will not be prepared due to standardized manufacture of product.
 - .8 Submit original drawings prepared by the Construction Manager, Sub-contractor, supplier or distributor to illustrate some portion of the work, showing fabrication, layout, setting or erection details.

- .9 Clearly indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, clearly indicate that all such articles and equipment have been properly coordinated, regardless of the trade under which the adjacent articles or equipment will be supplied and installed. Indicate cross references to design drawings and specifications.
 - .10 Provide a 75 mm x 75 mm free space for the application of the review stamp.
 - .11 Where Shop Drawings vary from requirements of Contract Documents as result of standard shop practice, changes in materials and methods or other reason, clearly point out variations on Shop Drawings. Any proposed deviations from the Contract Documents must be boldly indicated as such on the Shop Drawings. Do not otherwise infer or assume any acceptance.
 - .12 Adjustments made on Shop Drawings by the Consultant are not intended to change the Contract Price. If it is deemed that such adjustments affect the value of Work, request issue of a Change Order before proceeding with the Work.
 - .13 Make changes in Shop Drawings as the Consultant may require consistent with Contract Documents. When resubmitting, notify the Consultant in writing of any revisions other than those requested.
 - .14 If upon review by the Consultant, no errors or omissions are discovered, or if only minor corrections are made, and upon return and review of the Shop Drawing, fabrication and installation of the Work may proceed. If the Shop Drawings are rejected, noted copy will be returned and re-submission of corrected Shop Drawings, performed through the same procedure indicated above before fabrication and installation of Work may proceed.
 - .15 Upon completion of the review, the Consultant will retain one print and forward the marked-up copies to Construction Manager for printing and distribution.
 - .16 Provide the Consultant, within twenty (20) working days after award of contract, a Shop Drawing submission schedule including the date of submission, the date of review required, date required on site for all major equipment, materials and samples.
 - .17 Provide Shop Drawings for one trade as one complete set. Do not provide Shop Drawings in a "piece meal" fashion, ie. do not provide miscellaneous metal Shop Drawings for different handrails at different times. Accompany Shop Drawings with letter of transmittal listing numbers and latest dates of drawings submitted.
- 6.7 Product Data
- .1 Certain specification Sections specify that manufacturers' standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and other standard descriptive data will be accepted in lieu of Shop Drawings. Refer to individual Sections for specific requirements.
 - .2 The above will only be accepted if they conform to the following:
 - .1 Delete information which is not applicable to project.
 - .2 Supplement standard information to provide additional information applicable to project.
 - .3 Show dimensions and clearances required.
 - .4 Show performance characteristics and capacities.
 - .5 Show wiring diagrams and controls where applicable.
 - .3 Manufacturer's standard schematic drawings:
 - .1 Modify drawings to delete information which is not applicable to the project.
 - .2 Supplement standard information to provide additional information applicable to the project.
 - .3 Manufacturer's catalogue sheets, brochures, diagrams, schedules, performance charts, illustrations, and other standard descriptive data.
 - .4 Clearly mark each copy to identify pertinent materials, products or models.

- .5 Show dimensions and clearances required.
- .6 Show performance characteristics and capacities.
- .7 Show wiring diagrams and controls where applicable.

6.8 Metric Units

- .1 Use metric dimensions and quantities on all Shop Drawings and product data submitted, according to the 'Manual on Metric Building Drawing Practice' issued by the National Research Council of Canada. When metric units are not available, use imperial units. When listing both metric and imperial units, list metric units first.
- .2 Use scales in Shop Drawings, conforming to Table 4.4 of the Referenced Manual above.

6.9 Samples

- .1 Submit for review samples as the Consultant may reasonably require or as requested in the respective specification Sections.
- .2 Submit number of samples requested in each specification Section, or where not indicated submit a minimum of six (6) samples of each item requested.
- .3 Identification:
 - .1 Label samples with name of project, the Consultant's project number, supplier's name, Subcontractor's name, generic name of item, manufacturer's name, brand name and model number.
 - .2 Accompany sample shipments with transmittal letter referencing name of project, the Consultant's project number, drawing sheet detail, specification Section and paragraph number, and same information with which sample itself is labelled.
- .4 Deliver samples prepaid to the Construction Manager's business address; who will forward to Consultant.
- .5 Provide samples of special products, assemblies, or components when so specified.
- .6 Submit samples with reasonable promptness and in an orderly sequence, so as to cause no delay in the Work. Failure to submit samples in ample time will not be considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed. If requested, the Consultant will assist in preparing a schedule fixing the dates for submission.
- .7 Submit samples in ample time for the Consultant's review prior to quantity fabrication, or in the case of manufactured items, prior to placement of purchase orders.
- .8 Notify the Consultant in writing, at the time of submission, of any deviations in samples from requirements of Contract Documents.
- .9 Make changes in samples which the Consultant may require, consistent with Contract Documents.
- .10 Adjustments made on samples by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to Construction Manager subject to Consultant approval prior to proceeding with the Work.
- .11 The accepted samples establish the material standards for the work. No deviation permitted after review of samples. Label samples as to origin and intended use in the work.

6.10 Distribution of Submittals After Review

- .1 Distribute copies of Shop Drawings and project datum which carry the Consultant's stamp to:
 - .1 Construction Manager's file.
 - .2 Job site file.
 - .3 Record documents file.

- .4 Subcontractors.
- .5 Supplier.
- .6 Fabricator.
- .7 Owner.
- .2 Distribute samples as directed.
- 6.11 Progress Photographs
 - .1 Construction Manager to employ a competent individual to take all photographs.
 - .1 Digital photos: format .jpg, minimum 4 mega pixels in size.
 - .2 Submit by e mail or FTP site.
 - .3 Photos to include date stamp.
 - .2 Provide progress photos on a bi weekly basis to adequately portray the progress of the Work, and from locations specifically directed by the Consultant.
- 6.12 Consultant's Duties
 - .1 Review submittals with reasonable promptness.
 - .2 Review for:
 - .1 Design concept of project.
 - .2 Information given in Contract Documents.
 - .3 Review of separate items does not constitute review of an assembly in which the item functions.
 - .4 Affix stamp and initials or signature certifying to review of submittal.
 - .5 Return submittals to Construction Manager within 14 calendar days of submission for distribution.
- 6.13 Construction Manager's Responsibilities
 - .1 Review Shop Drawings, project data, and samples prior to submission.
 - .2 Verify:
 - .1 Field measurements.
 - .2 Field construction criteria.
 - .3 Catalogue numbers and similar data.
 - .3 Coordinate each submittal with requirements of work and of the Contract Documents.
 - .4 The Construction Manager's responsibility for errors and omissions in submittals is not relieved by the Consultant's review of the submittals. Make good increase to the Contract Price, errors or omissions on Shop Drawings, which are discovered later and are necessary to complete the Work as intended on the Contract Documents.
 - .5 The Subcontractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved by the Consultant's review of submittals, unless the Consultant gives written acceptance of specific deviations.
 - .6 Notify the Consultant in writing at the time of submissions, of deviations in submittals from requirements of the Contract Documents.
 - .7 Begin no work which requires submittals until return of the submittals with review stamp and initials or signature indicating review.
 - .8 Performance of any Work prior to the return of reviewed Shop Drawings is at the risk of the Construction Manager and must be changed if the reviewed drawings so indicate.

- .9 If required by the Consultant, submit Shop Drawings of items of work issued by the Consultant in the form of change orders.
- 6.14 Certificates and Transcripts
- .1 Immediately after award of Contract, submit Workers' Compensation Board status and transcription of insurance.
- 6.15 Mock-Ups
- .1 Provide mock-ups for the items of work as specified in the individual specification Sections.
- .2 Co-ordinate construction of mock-ups so that the same personnel will supervise construction of the various parts as will do so in the finished Work.
- .3 Co-ordinate construction of mock-ups so that the same personnel will supervise construction of the various parts as will do so in the finished Work.
- .4 Construct sample areas at location designated by the Consultant.
- .5 Prepare mock-ups for Consultant's review with reasonable promptness and in an orderly sequence so as not to cause any delay in the Work.
- .6 Failure to prepare mock-ups in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .7 Where required, provide mockups which involve work of more than one trade, i.e - exterior wall mockups, which include windows and frames, curtain wall, sill, air/vapour barriers, Z girts, strapping, insulation, flashing and cladding.
- .8 If requested, the Consultant will assist in preparing a schedule fixing the dates for preparation.
- .9 Sample installations must indicate materials, patterns, joints, colours, shades, installation methods and level of workmanship.
- .10 Adjust sample installations as required to conform with the referenced standards, the drawings, and this specification, and to gain acceptance by the Consultant, at no additional cost to the Owner.
- .11 Accepted sample installations will become the standard for the project and may be incorporated into the Work, if the mockup is in an undisturbed condition at time of Substantial Performance of the Work and may become part of the completed Work where they form a part of the completed Work. Any work which does not match the accepted mock-ups will be rejected and replaced to match accepted mock-ups.
- 6.16 Operation and Maintenance Manuals
- .1 Two weeks prior to Substantial Performance of the Work, submit to the Consultant, three (3) copies of operation and maintenance manuals. Include 1 digital copy of Operation and Maintenance Manuals. Submit digital copy for review 2 weeks prior to submitting hard copy O and M manuals.
- .2 Bind contents in a three-ring, hard covered binder. Organize contents into applicable categories of work, parallel to specification Sections. Upgrade to meet Divisions 22, 23,25, 26, 27, 28 and 33 requirements where applicable. Bind data as follows:
- .1 Bind data in hard covered, three ring loose leaf binders for 216 mm x 279 mm size paper.
- .2 Enclose title sheet, labelled "Operation and Maintenance Manual", project name, date and list of contents.
- .3 Label binder face and spine with Project title, date, Project locations, manual title and volume number with printed non-removable labels or silk screened lettering.
- .4 Organize contents into applicable Sections of work to parallel project specification breakdown. Identify each Section by labelled tabs protected by celluloid covers fastened to hard paper dividing sheets.

- .5 Provide three sets of binders for Divisions 00 to 14, 31 and 32 and three sets of binders for Divisions 22, 23 and 33 and three sets of binders for Divisions 25, 26, 27 and 28.
 - .3 Include in the Architectural manuals the following information, together with the data specified in each Section:
 - .1 Manufacturer's maintenance guides, parts lists and name and address of nearest vendor of parts and any special tools required for maintenance of building components with movable parts.
 - .2 Copy of installed hardware schedule.
 - .3 List of materials installed giving manufacturer's name and manufacturer's code name for products.
 - .4 Names, addresses and phone numbers of Subcontractors and suppliers.
 - .5 Copy of all guarantees and warranties issued.
 - .6 Copy of all reviewed shop drawings with all data concerning changes made during construction. (Only one set of reviewed shop drawings required - install in one manual only or in a 4th binder specifically titled shop drawings).
 - .7 Where contents of manual include manufacturer's catalogue pages, clearly indicate the precise items included in this installation and delete, or otherwise clearly indicate, all manufacturer's data with which this installation is not concerned.
 - .4 Manuals to contain operational information on equipment, cleaning and lubrication schedules, filters, overhaul and adjustment schedules and similar maintenance manuals. Provide schematic drawings for all equipment and components.
 - .5 Where there is a conflict between this Section and Divisions 22, 23, 25, 26, 27, 28 and 33, allow for the more expensive method.
 - .6 Provide temporary instruction for any piece of equipment which is used during the construction period.
 - .7 Final payment will not be released prior to receipt of the Operation and Maintenance Manuals.
- 6.17 Record Drawings
- .1 Construction Manager will maintain a set of drawings for the purpose of record drawings on site. Accurately and neatly record deviations from Contract Documents caused by site conditions, clarification details or drawings and changes ordered and other forms of written modification issued. Update on a daily basis.
 - .2 Record all changes in red, using suitable notation and ensure revisions to elevations and location of all concealed components including, foundations, mechanical and electrical services are detailed. Indicate all changes made by Change Order or Supplementary Instruction.
 - .3 Refer to Divisions 22, 23, 25, 26, 27, 28 and 33 for specific Mechanical and Electrical requirements regarding preparation and submission of final Project Record Drawings.
 - .4 Identify drawings as "Project Record Copy". Maintain in new condition and make available at all times for review on site by Consultant.
 - .5 On completion of Work and prior to final review, submit record documents to Consultant. Also, print one complete set of marked up record drawings for the Owner.
 - .6 Sign each drawing and provide a Certificate of Record, as illustrated in the following paragraph, signed by persons authorized to sign on behalf of the Construction Manager, and to bind the Construction Manager as to the correctness of the drawings. Deliver one complete set of drawings to the Consultant to be so certified prior to deliver of same to the Owner. This certified set is the official set of as-built drawings and will be kept by the Owner in a secure place.

- .7 Incorporate a statement of Certificate of Record for the as-built Drawing set, to read as follows:

RECORD DRAWINGS
Yukon University
Polaris Project

6.18 Progress Reports

- .1 Construction Manager will :
- .1 Keep a permanent written record on site of progress of the Work, including information from Subcontractors. Maintain this record open to review by the Consultant. Furnish a copy to the Consultant upon request.
 - .2 Indicate dates of commencement and completion of trades and parts of the work coming under the Contract, including reports on daily weather conditions, excavation work erections and removal of forms and other similar pertinent information relevant to the Work. Submit to the Consultant at regular monthly intervals.
 - .3 Report delays (and potential delays) relevant to their work, giving reason for delay and action being taken to resolve the problem.
 - .4 Record all visitors' names.
 - .5 Record details of all accidents or other unusual occurrences.

7. SCHEDULES

7.1 Schedules Required

- .1 Refer to Prime Contract Agreement for Schedules.
- .2 Construction Manager and Consultant will review durations of scope provided by Subcontractor's and return any comments within 20 days after receipt.

8. QUALITY CONTROL

8.1 Reviews

- .1 Construction Manager and Subcontractor will:
- .1 Provide the Owner and the Consultant with access to the Work.
 - .2 Give Owner and Consultant minimum 48 hours notice requesting review of Work as designated for special tests, reviews or acceptances by the Consultant's instructions, or the law of the place of Work.
- .2 If the Construction Manager and Subcontractor covers or permits to be covered, Work that has been designated for special tests, reviews or acceptances before such is made, especially mechanical and electrical work in concealed spaces, uncover such Work, have the reviews or tests satisfactorily completed and make good such work.

8.2 Codes and Standards

- .1 Perform work in accordance with the National Building Code, Workers' Compensation Board of National, and all other codes of provincial or local application provided that any case of conflict or discrepancy, the more stringent requirements apply.
- .2 Meet or exceed requirements of specified standards, codes and documents.

8.3 Independent Inspection Agencies

- .1 The Owner will engage Independent inspection and testing agencies for the purpose of inspecting and testing portions of the Work.
- .2 Equipment required for executing inspection and testing will be provided by appointed agencies.

- .3 Where materials are specified to be tested, deliver representative samples in required quantities to testing laboratory.
- .4 The Construction Manager will pay for the following testing and inspection services:
 - .1 Hire and pay for inspections on: structural steel, roofing.
 - .2 Construction Manager will review with the contracted company for testing of soils, compaction, concrete, and asphalt.
 - .3 Retesting and Reinspection of Work by Independent testing agencies, which was rejected after the initial testing which was paid for by the Owner.
 - .4 Inspection and testing required by law, ordinances, rules, regulations or orders of public authorities.
 - .5 Inspection and testing performed exclusively for the Construction Manager's convenience.
 - .6 Mill tests and certificates of compliance.
 - .7 Tests specified to be carried out by the Contractor under the supervision of the Consultant.
 - .8 Testing adjustment and balancing of conveying systems, mechanical and electrical equipment and systems.
 - .9 Materials, scaffolding and labour required to facilitate testing.
 - .10 After rectification, re-testing of work found deficient by previous tests.

8.4 Reports

- .1 Construction Manager will:
 - .1 Submit digital PDF copies of inspection and test reports, including reports from independent testing agency, promptly to the Consultant.
- .2 Provide copies to:
 - .1 Subcontractor of work being inspected or tested.
 - .2 Manufacturer or fabricator of material being inspected or tested.

8.5 Remedial Work

- .1 Construction Manager will:
 - .1 Ensure all remedial work required as a result of deficiencies or work which does not meet the Contract Documents, at no cost to the Owner. Additional tests required to ascertain if remedial work complies with Contract Documents will be borne by the Construction Manager.
- .2 Patch and make good damage resulting from cut tests and other destructive testing, to match adjacent construction.

9. **CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS**

9.1 Installation and Removal

- .1 If not specified in Subcontractor's scope of Work, Construction Manager will provide construction facilities and temporary controls in order to execute the work expeditiously.
- .2 Coordinate with the Construction Manager, which temporary facilities and controls will be provided by the Subcontractors and which temporary facilities and controls will be provided by the Construction Manager.
- .3 Remove from site all such work after use.
- .4 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required to access the work.

9.2 Requirements of Regulatory Agencies

- .1 Construction Manager and Subcontractors will comply with all related requirements of the Workers' Compensation Board of the Territories, the National Building Code and all authorities having jurisdiction including utility company requirements.

9.3 Hoarding

- .1 Construction Manager will:
 - .1 Erect hoarding around entire perimeter of lay down areas and site trailer, to protect the public, workers, public and private property from injury or damage and to the approval of the authority having jurisdiction.
 - .2 Provide hoarding with prefabricated temporary steel framed construction fence with mesh, 2400 mm high, with sections interlocked together and fence being self supporting, protecting public and private property from injury or damage.
 - .3 Provide lockable gates within hoarding for access to site by workers and vehicles. Ensure hoarding is completely secure when work is not in progress.
 - .4 Locate all construction trailers, garbage chutes, garbage bins, hoists, equipment, tools and the like, within the confines of the exterior hoarding.
 - .5 Remove barriers prior to completion and final acceptance. Patch and repair surfaces to original condition damaged by erection of barriers.

9.4 Guard Rails and Barricades

- .1 Construction Manager or its Subcontractor will:
 - .1 Provide secure, rigid guard railings and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs garbage chutes and hoists. Design to best practices and Workers Compensation Board requirements.
 - .2 Provide as required by authority having jurisdiction.
 - .3 Neatly assemble and firmly brace.
 - .4 Maintain as required during construction period.
 - .5 Patch and repair surfaces to original condition damaged by erection of barriers.

9.5 Dust and Fume Control

- .1 Construction Manager or its Subcontractors will:
 - .1 Provide dust and fume tight screens or partitions to localize dust and fume generating activities, and for the protection of workers, finished areas of Work and the public.
 - .2 Provide a Shop Drawing indicating partition plan, including dimensions, configurations and access doors and dust and fume control measures.
 - .3 Provide strict dust and fume control to localize dust-generating activities, and for the protection of workers, finished areas of Work and the public. Ensure that mechanical system is blocked off during the progress of the Work to prevent the spread of dust to other portions of the building which are being used by the Owner.
 - .4 Provide, maintain and relocate protection until dust-generating activities are complete.
 - .5 Provide temporary floor mats at entrance to the work site. Maintain and replace mats on a regular basis.
 - .6 Remove barriers prior to completion and final acceptance. Patch and repair surfaces to original condition damaged by erection of barriers.

9.6 Dewatering

- .1 Construction Manager or its Subcontractor will:
 - .1 Provide temporary drainage and pumping facilities to maintain excavations and site free of standing water.

9.7 Hoisting

- .1 Construction Manager or its Subcontractor will:

- .1 Provide, operate and maintain hoists required for moving of workers, material and equipment. Make financial arrangements with Subcontractors for use thereof.
- .2 Operate hoists using qualified operators.
- .3 Adequately secure all loads.

9.8 Preventing Mould during Construction

- .1 Construction Manager will:
 - .1 Monitor interior relative humidity conditions in relation to surface temperatures to prevent generation of moisture that may contribute to mould growth on the surface of organic construction materials.
 - .2 If using temporary heaters, use a type that exhausts combustion products directly to the exterior of building enclosures. Do not use temporary heaters that exhaust combustion products into building enclosures.
 - .3 Install insulation concurrently with air/vapour barrier or vapour retarder.
 - .4 Protect all organic construction materials from the elements, before, during, and after their installation.
 - .5 Refer to CCA 82 "Mould Guidelines for the Canadian Construction Industry", published by the Canadian Construction Association, for additional information about mould, its implications and recommendations on its prevention.
 - .6 Promptly report to the Consultant any mould growth observed at the work site. If the Consultant determines that such mould growth was caused by the Contractor's operations, the Contractor must promptly remove it in accordance with procedures prescribed by the Consultant, at no cost to the Owner.
 - .7 Include third party report of clean-up.

9.9 Scaffolding

- .1 Construction Manager or its Subcontractors will:
 - .1 Provide and maintain scaffolding, ramps, ladders, swing stages, platforms and temporary stairs.
 - .2 Erect scaffolding independent of walls. Use scaffolding with the least possible interference with the Work. Construct and maintain scaffolding in rigid, secure and safe manner. Remove scaffolding promptly when no longer required. Erect and place scaffolding to permit convenient access to all levels for all workers, the authority having jurisdiction, the Consultant and the Owner.

9.10 Access to Site

- .1 Maintain free and unimpeded access to and egress from site at all times.
- .2 Access to construction area permitted only through designated approaches in such manner that traffic will not interfere with Owner's activities. Access from other parts of the site will be permitted for special purposes only and will require prior written acceptance from the Owner or Consultant for each special purpose.
- .3 Whenever interference with normal street and sidewalk traffic becomes necessary for proper and convenient performance of the work, and no satisfactory detour route exists, provide satisfactory detour, temporary bridge, or other proper facility for traffic to pass around or over interference, and maintain in satisfactory condition as long as interference continues. Obtain road and sidewalk closure permits from Authorities Having Jurisdiction. Provide before beginning interference.
- .4 Make arrangements for closing off the street and sidewalks during construction and provide the necessary covered pedestrian walks and detours to facilitate access to the buildings and to protect the public during the work of this project.

9.11 Public Traffic Flow

- .1 Construction Manager and its Subcontractors will:
 - .1 Provide and maintain flag persons, traffic signals, barricades and flares/lights/lanterns as required by The Authorities Having Jurisdiction bylaws and as necessary to perform the Work and protect the public.
 - .2 Maintain access to all portions of the site for fire fighting equipment to the satisfaction of the local Fire Department.

9.12 Parking

- .1 Coordinate with Construction Manager.
- .2 Any vehicles improperly parked will be removed at the vehicle owner's expense.

9.13 Sanitary Facilities

- .1 Construction Manager will :
 - .1 Provide sufficient portable sanitary facilities during the construction period for workers, in accordance with local health authorities and Occupational Health and Safety Code.
 - .2 Maintain in clean condition.
 - .3 The use of the permanent and existing washroom facilities will not be permitted.
 - .4 Provide separate facilities, as required, for men and women, appropriately identified.

9.14 Temporary Heating and Ventilating

- .1 Construction Manager will :
 - .1 Use whatever means necessary, and acceptable to the Owner, to prevent passage of dust from construction area.
 - .2 Provide and pay for temporary heating, as may be required for areas within weather proof enclosures, such as required to facilitate installation of concrete floor patching materials, waterproofing and the like, including attendance, maintenance and fuel.
 - Maintain temperatures of minimum 15°C within weatherproof enclosures where construction is in progress, unless indicated otherwise in the Product specification Section.
 - Provide adequate ambient temperatures and humidity levels for storage, installation and curing of materials.
 - Ventilate heated areas and keep building free of exhaust or combustion gases and to meet health regulations for a safe working environment. Prevent hazardous accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.
 - If propane gas is required for temporary heating, be aware of and accountable for the potential problems which have been experienced with condensation containing mineral oil or mineral spirits in solution which in turn attack glazing sealants and compounds. Be entirely responsible for preventing all detrimental effects from the use of the propane gas in all aspects of the materials and finishes used in construction of the Work.
 - Be responsible for damage to the Work due to failure in providing adequate heat and protection during construction.
 - Contractor responsible for the hookup, pay and removal of temporary gas services.
- .2 The permanent heating system of the building, or portions thereof, will be used during construction prior to completion. All warranties will be extended and equipment cleaned prior to final handover. Be responsible for damage thereto. Use of the permanent heating system, prior to Substantial Performance of the Work will not impact on the warranty obligation as noted in the specifications.

- .3 Operate permanent heating system under conditions which ensure no temporary or permanent damage, under the direction of the Heating Subcontractor who is fully responsible for the safety of the system and its operation, including the provision of trained operators. Operate fans at proper resistance with filters installed. Change filters at regular intervals. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.
 - .4 Provide additional ventilation to heated areas and keep building free of exhaust or combustion gases and to meet health regulations for a safe working environment. Prevent hazardous accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction. Provide additional heating as may be required, beyond that provided by the Owner.
- 9.15 Humidity Control
- .1 Do not exceed the normal building operating relative humidity of the air in the building, during construction. Provide appropriate humidity for the work being performed.
 - .2 To achieve this requirement, it may be necessary to use portable temporary heating units of the type which heat and force fresh air into the building.
 - .3 Vent moist air to the exterior. Avoid causing pressurization of the building during construction.
 - .4 Millwork and finishing materials must be acclimated prior to installation.
- 9.16 Water Supply
- .1 Construction Manager will :
 - .1 Arrange and maintain a continuous supply of potable water for construction use in accordance with governing regulations and ordinances.
 - .2 Arrange for connection with appropriate utility company and pay all costs for installation, maintenance, consumption and removal.
 - .3 Provide all hoses and other means of distribution as required.
- 9.17 Temporary Power and Light
- .1 Construction Manager will :
 - .1 Provide and pay for temporary power required during construction for temporary lighting and operating power tools.
 - .2 Arrange for connection with appropriate utility company. Pay all costs for installation, maintenance and removal.
 - .3 Provide all necessary temporary connections required to temporary power source. Provide centrally located power panels for the use of all Subcontractors.
 - .4 Provide and maintain temporary lighting throughout the project. Provide a level of illumination on all floors and stairs of not less than 15 foot candles. Replace burnt out or missing lamps.
 - .2 Do not use temporary power for welding. Use self-generator units for all welding power.
 - .3 When work is performed at night or where daylight is obscured, provide artificial light sufficient to perform work properly and to permit thorough review.
 - .4 Take precautions to ensure that electrical disturbances are not transmitted to electrical distribution system.
- 9.18 Equipment/Tool/Materials Storage
- .1 Provide and maintain, in a clean and orderly condition, lockable weatherproof sheds or trailers suitable for storage of tools, equipment and materials and to protect from weather or construction. Materials, equipment and tools may be stored within the confines of the Work area. Provide trailers as required to accommodate storage beyond that available within the Work area.

- .2 Locate materials required to be stored on site in a manner to cause the least interference with work activities, in an area designated by the Owner.
 - .3 All Contractor's and Subcontractor's tools and equipment must be in good physical condition.
- 9.19 Fuelled and Gas Welding Machines and Air Compressors
- .1 The Contractor and each respective user of fuelled or gas welding machines or air compressors is responsible for such equipment.
 - .2 Locate on outside of building. Ensure apparatus is not open to physical damage and extremes of heat and is securely anchored to a stable truck.
- 9.20 Construction Sign
- .1 Do not exhibit on site, any signs or advertisements, other than warning signs without permission of the Owner.
 - .2 Safety and Instruction Signs and Notices:
 - .1 Signs and notices for safety and instruction including graphic symbols conforming to CAN3 Z321.
 - .3 Maintenance and Disposal of Site Signs: Maintain accepted signs and notices in good condition for duration of project, and dispose of off site on completion of project or earlier if directed by Consultant.
 - .4 Prior to commencement of Work where hazardous or volatile materials or substances are used, barricade entire area and post adequate number of "NO SMOKING" signs.
- 9.21 Offices
- .1 Construction Manager will provide a site trailer as the site office, solely for Construction Manager's use.
 - .2 Construction Manager may assign a location for Subcontractors site office and material storage. Subcontractor is responsible for erecting and dismantling such office returning to original state when no longer needed, at Subcontractor's cost.
 - .3 Maintain, in a clean and orderly condition, during progress of Work. Permit the Consultant to use the facilities.
 - .4 Provide adequate required first aid facilities as required by Occupational Health and Safety Code and the authority having jurisdiction.
- 9.22 Security
- .1 During non working hours, secure the areas under construction so as to render areas inaccessible to unauthorized individuals.
 - .2 Assume full responsibility for any losses or damages to materials, fixtures or equipment whether due to failure to properly secure the work site or for any other reason whatsoever.
 - .3 Ensure that access locations in hoarding to the work site are securely locked after working hours and during holidays, and that equipment and machinery, within the work site hoarding area, is properly locked or otherwise rendered inoperable to any unauthorized individuals.
- 9.23 Protection
- .1 Carefully maintain existing benchmarks, monuments and other survey control references.

- .2 Take precautions at all times to protect persons, including the public, The Owner, Contractor's employees, Subcontractor's and their employees, and property affected in any way by the work whether direct or incidental. Especially guard against and eliminate hazardous conditions.
 - .3 Protect Work against possible damage from:
 - .1 Ground water, surface and rain water.
 - .2 Snow, ice and frost. Remove snow, ice and frost where necessary for efficient progress.
 - .3 Climatic and weather conditions.
 - .4 Fire.
 - .4 Be responsible for damage incurred, and remove and replace with new Work at no extra cost to the Owner.
 - .5 Protect adjacent roads and private property from damage, including from dust and falling objects, during construction.
 - .6 Provide and maintain all necessary overhead protection in public areas during the progress of the Work.
- 9.24 Protection of Building Finishes and Equipment
- .1 Provide protection for finished, partially finished and existing building finishes and equipment during performance of the work.
 - .2 Provide all necessary screens, covers, hoardings as required.
 - .3 Be responsible for damage incurred due to lack of protection or improper protection.
 - .4 Provide preventative measures to minimize wear and tear both on and off the site and restore areas damaged by Construction activities.
- 9.25 Existing Services
- .1 Existing services and structures include pipelines, culverts, ditches, manholes, catch basins, pole lines, other items which are part of an existing drainage, sewerage, water, gas, power, telephone, swales, fences and buildings.
 - .2 Make arrangements with the owner of existing services to determine the actual location of underground services which may affect the Work. Cooperate with owners of existing services and obey their notices. Repair any damage which occurs.
 - .3 Maintain the flows in all ditches, water courses, water mains, sewers and drains encountered during the Work.
 - .4 Ensure existing services which are to remain in streets and laneways are not disturbed.
 - .5 No additional payment will be made for this work, the cost being deemed to be included in the Contract, unless noted otherwise.
- 9.26 Special Controls
- .1 Noise and Dirt:
 - .1 Gain written approval for all noisy work by owner in advance of performing work. 2 week minimum notice is required.
 - .2 Any jack hammering or noise that may disturb the neighbouring tenants is to be completed in accordance with the City bylaws.
 - .2 Explosive Actuated Fastening Tools:

- .1 Do not use explosive actuated fastening tools on this project without the prior written acceptance of the Consultant.
 - .2 When using explosive actuated fastening tools conform to the requirements of CSA Z166 - "Explosive Actuated Fastening Tools" and the requirements of the authority having jurisdiction.
 - .3 Operate tools only by persons possessing an operator's certificate indicating that they are qualified to use such tools.
- .3 Site Storage and Overloading:
- .1 Confine apparatus, storage of products, and operations of employees to limits indicated by laws, ordinances, permits or the Contract Documents and to not unreasonably encumber the premises with products.

9.27 Completion

- .1 On completion of the Work, remove all temporary protection erected under this Section, make good all damage to this work and adjoining work resulting from the execution of the work, and remove from the premises all surplus materials and debris, and all tools, plant, and equipment. Leave the building and site in a clean tidy condition satisfactory to the Consultant.

10. MATERIALS AND EQUIPMENT

10.1 Minimum Standard

- .1 Perform Work in accordance with the standards set forth in the building code.
- .2 Where a material or item is required to conform to standards set out in a standard specification such as CSA or ASTM or CGSB or ANSI and the like, obtain assurance from supplier, in writing, (including trade literature), that its product conforms.
- .3 Ensure all standard specifications are the latest issue at time of bid closing, regardless of date indicated on standards in the individual specification Sections, except when a year date is indicated.
- .4 Upon request, supply the Consultant with satisfactory evidence that material complies with Standard Specification or test requirements.
- .5 Where a material is designated for a certain application unless otherwise specified, ensure that the material conforms to standards designated in the National Building Code, together with all its related supplements. Similarly, unless otherwise specified, installation methods and standards of workmanship must also conform to standards invoked by the aforementioned code. Where no particular material is specified for a certain use, select material from the choice offered in the code in each case; also obtain Consultant's acceptance.
- .6 Where the aforementioned code or this specification does not provide all information necessary for complete installation of an item, strictly comply with the manufacturer's instructions for first quality workmanship.

10.2 Quality of Products

- .1 Unless otherwise stipulated elsewhere in the Contract Documents, provide and pay for labour, products, tools, construction machinery and equipment, water, heat, light, power, transportation and other facilities and services necessary for the performance of the Work in accordance with the Contract.
- .2 Products provided shall be new unless otherwise specified in the Contract Documents. Products which are not specified shall be of a quality best suited to the purpose required and their use subject to the approval of the Consultant.
- .3 Maintain good order and discipline among their employees engaged on the Work and shall not employ on the work anyone not skilled in the task assigned to him.

- .4 Defective Products will be rejected regardless of previous reviews. Review does not relieve responsibility, but is a precaution against oversight or error. Review by Consultant does not relieve Contractor's responsibility, but is merely a precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.
- .5 Should any dispute arise as to the quality or fitness of Products, the decision rests strictly with the Consultant based upon the requirements of the Contract Documents.
- .6 Unless otherwise indicated in the specifications, maintain uniformity of manufacturer for any particular or like item throughout the building.
- .7 Permanent labels, trademarks and nameplates on materials, equipment and articles are not acceptable in prominent locations, except where required for operating instructions, and when located in mechanical or electrical rooms. For waiver of this requirement, submit proposal with shop drawing.
- .8 Ensure the flame spread rating of floor, wall and ceiling finishes including glazing conforms to the Building Code.

10.3 Availability of Products

- .1 Immediately upon award of Contract, review product delivery requirements and anticipate foreseeable supply delays for any items. If delays in supply of materials, equipment or articles are foreseeable, notify the Consultant of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work. Submit confirmation of ordering of materials.
- .2 In the event of failure to notify the Consultant at commencement of Work and should it subsequently appear the Work may be delayed for such reason, the Consultant reserves the right to substitute more readily available products of similar character, at no increase in Contract Price.

10.4 Substitutions

- .1 Prior to commencement of Work Submit to the Consultant a complete list of all products which are proposed for installation.
- .2 For products specified only by reference to standards use any product which meets the standard, made by any manufacturer.
 - .1 Use of such reference is intended to establish the measure of quality which the Consultant has determined as required and necessary for the project.
 - .2 When materials are specified by standards, upon request of the Consultant, obtain from the manufacturer and independent laboratory, a report stating the product meets or exceeds the requirements or specified standards.
- .3 For products specified by naming several products or manufacturers use any product named.
- .4 For products specified by naming one product there is no option unless the Consultant has accepted an alternative product in writing.
- .5 Products specified by a "descriptive" or "performance" specification; select any product meeting or exceeding specification.
- .6 Products specified by describing proprietary items, model numbers, catalogue numbers, naming manufacturer and trade names or similar references; select product and manufacturer named or products accepted as substitutions prior to bid closing.
- .7 When materials are specified by standards, upon request of the Consultant, obtain from the manufacturer and independent laboratory, a report stating the product meets or exceeds the requirements or specified standards.

- .8 The Consultant will not consider any claim by the Subcontractor of unsuitability or unavailability of any material, nor his unwillingness to use, nor his inability to produce first-class work with the same unless the claim is submitted in writing with his Bid.
- .9 For acceptance of products other than those specified, submit a request in writing. Clearly define and describe the product for which acceptance is requested. Accompany Requests with manufacturer's literature, specifications, drawings, cuts, performance data, or other information necessary to completely describe the item. Acceptance by the Consultant will be in the form of written acceptance of the alternative. Clearly indicate the amount of credit, or the additional cost involved, so that adjustment to the Contract can be made.
- .10 With requests for substitution include:
 - .1 Complete data substantiating compliance of the proposed substitute with contract requirements.
 - .2 For products: product identification, including manufacturer's name and address; manufacturer's literature, including product description, performance and test data, reference standards, and limitations; samples, if appearance is relevant; names and addresses of similar projects where the product has been used.
 - .3 For construction methods: detailed description of the proposed method, and drawings illustrating it.
 - .4 Itemized comparison of proposed substitution with product or method specified.
 - .5 Data relating to changes in schedule.
 - .6 Quotation for change in contract sum if substitution is approved.
 - .7 In making a request for substitution the Contractor represents that he has personally investigated the proposal and determined that it is equal or superior to the product or method specified; that the same guarantee will be furnished for the substitute as for the original; that he will co-ordinate installation of the accepted substitute into the work, making such changes in the work as may be required to accommodate the change; that he waives all claims for additional compensation for costs which subsequently become apparent arising out of the substitution; and that the quotation is complete and includes all related costs under this contract.
 - .8 Substitutions will not be considered which are implicit in submitted shop drawings or samples rather than formally presented proposals as described above.
 - .9 Substitutions will not be considered which require substantial changes in the contract documents.
- .11 After award of Contract, Proposals will be considered by the Consultant only if products selected from those specified are not available, or if delivery date of products selected from those specified would unduly delay completion of the Contract, or if alternative products to those specified, which are brought to the attention of and considered by the Consultant as equivalent to those specified and will result in a credit to the Contract amount.
- .12 Advise the Consultant of all adjustments and changes necessary in the work to accommodate the substitution. The decisions of the Consultant as to whether the substitution proposed is acceptable is final. The proposed substitutions must meet or exceed the specified product.
- .13 If no substitution is requested, and if no provisions to the contrary have been made in the Contract, for the item in question, provide the item named in these specifications.
- .14 Should the proposed substitution be accepted either in part or in whole, assume full responsibility when the substitution affects the work of any other Section of the specifications. Pay for any drawing changes required as a result of the substitution, and all costs for changes to the work resulting from the substitution.
- .15 Credits arising from the use of substitutions will be credited to the Contract in such amounts as may be determined by the Consultant and the Contract price will be adjusted accordingly. No substitutions will be permitted without the prior written permission of the Consultant.
- .16 Include acceptability of the National Building Code, if required, for all substitution acceptances of products.

- 10.5 Storage, Handling and Protection of Products
- .1 Handle and store Products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
 - .2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact.
 - .3 Store products subject to damage from weather in weatherproof enclosures.
 - .4 Manufacturer's Instructions:
 - .1 Unless otherwise indicated in the specifications, install or erect Products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.
 - .2 Notify the Consultant in writing, of conflicts between the specifications and manufacturer's instructions so the Consultant may establish the course of action.
 - .3 Improper installation or erection of Products, due to failure to comply with these requirements authorizes the Consultant to require removal and reinstallation at no increase in Contract Price.
 - .5 Workmanship:
 - .1 Workmanship shall be the best quality, executed by workers experienced and skilled in the respective duties for which they are employed. Immediately notify the Consultant if required Work is such as to make it impractical to produce required results.
 - .2 Do not employ any unfit person or anyone unskilled in their required duties.
 - .3 Decisions as to the quality or fitness of workmanship in cases of dispute rest solely with the Consultant, whose decision is final.
 - .6 Concealment:
 - .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
 - .2 Before installation, inform the Consultant if there is a contradictory situation. Install as directed by Consultant.
- 10.6 Transportation
- .1 Pay costs of transportation of materials, equipment and articles required in the performance of the Work.
 - .2 Transport materials in covered trucks to prevent contamination of products or littering of surrounding area.
- 10.7 Coordination
- .1 Ensure cooperation of workers in laying out Work. Maintain efficient and continuous supervision.
 - .2 Be responsible for coordination and placement of openings, sleeves and accessories.
 - .3 Verify that field measurements are as indicated on construction and/or shop drawings before confirming product orders or proceeding with work, in order to minimize waste due to excessive materials.
- 10.8 Project Control
- .1 Ensure the following:
 - .1 only specified or accepted materials are used.
 - .2 installation is in accordance with the drawings and specifications and to manufacturer's directions, or to methods which have been submitted and accepted in writing by the Consultant, prior to proceeding with the Work.

- .3 these requirements are made clear to the trade foreman prior to the work of their trade commences at the site.

10.9 Joints

- .1 Make joints of uniform width. Arrange joints for the best visual effect where joint locations in exposed work are not indicated:
 - .1 Obtain Consultant's acceptance of joint locations prior to final installation of materials.
 - .2 Consultant retains the right to adjust location of joints to suit design criteria, provided that adjustment does not affect maximum areas recommended for materials being installed.
 - .3 Fit exposed connections together to form hairline joints.
- .2 Do not use products, cleaners, and installation materials that are considered hazardous.

10.10 Location of Fixtures

- .1 Consider the location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
- .2 Inform the Consultant of a conflicting installation. Install as directed by the Consultant.

10.11 Fastenings

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless otherwise indicated in specifications. Use concealed fastenings in finish work unless otherwise indicated.
- .2 Prevent electrolytic action between dissimilar metals and materials, by means of suitable coating or separation layer.
- .3 Ensure that there is solid wood blocking for heavy wall mounted items and sheet metal blocking for other wall mounted items, in steel stud and gypsum board walls and solid concrete fill in masonry walls, behind surface mounted items on walls.
- .4 Use non-corrosive or hot dip galvanized fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in the affected specification Section.
- .5 Use predrilled insets when attaching to masonry or concrete.
- .6 Space anchors within their load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .7 Keep exposed fastenings to a minimum, space evenly and install neatly and only at locations approved by the Consultant.
- .8 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.
- .9 Provide for the use of explosive actuated fastening tools when required. Conform to the requirements of CAN3 Z166 Series - "Power Actuated Tools - Performance Requirements" and local governing authorities. Obtain Consultant's approval prior to using explosive activated fastening tools on this project.
- .10 Ensure that these tools are used by persons having had instruction on their use as required by the National Occupational Health & Safety Regulations.
- .11 Ensure bolts do not project more than one diameter beyond nuts.
- .12 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

- 10.12 Roughing-In
- .1 Be responsible for obtaining manufacturer's literature and for correct roughing-in and hook-up of all equipment, fixtures and appliances as required.
- 10.13 Sleeves, Anchors, Hangers and Supports
- .1 Provide and set sleeves where conduits pass through masonry or concrete.
- .2 Do not pierce concrete slabs with hanger wires, rods, brackets, bolts, inserts and other connections, except as authorized by the Consultant. Submit methods of fixing to the Consultant for acceptance, prior to commencement of operation.
- .3 Be responsible for all system pipe, conduit and equipment anchors, hangers and support systems and connections to building structure and employ a Professional Engineer registered in the Yukon Territory to design such anchors, hangers, support systems and connections to building structure. Make engineering design notes available to the Consultant upon request.
- .4 Fixing to steel decks from below: do not pierce top flute.
- 10.14 Field Marking
- .1 Do not use wick pen to mark face of products to be installed in the Work. Such pen marks will show through applied paint or vinyl coatings and the like, in due course. Be responsible for and remedy such defects, classified as "latent defects" regardless of when they occur.
- 10.15 Trademarks and Labels
- .1 Ensure trademarks and labels, including applied labels, are visible in the finished Work. Do not remove such trademarks or labels by grinding if necessary, or painted out where the particular material has been painted.
- .2 Include all those trademarks and labels essential to obtain identification of mechanical and electrical equipment, and those required to be visible by authorities having jurisdiction such as ULC labels on doors and frames, and those on plumbing fixtures and trim and CSA labels for electrical items.
- 10.16 Protection of Work in Progress
- .1 Adequately protect Work completed or in progress. Repair or remove and replace work damaged or defaced due to failure in providing such protection as directed by the Construction Manager, at no increase in the Contract Price.
- 11. SAFETY**
- 11.1 Safety Requirements
- .1 Comply with and enforce the construction safety measures required by the National Building Code, the Workers' Compensation Board, and applicable provisions of Federal, Provincial and Municipal safety laws and ordinances. Construction Manager is responsible for safety of the project site.
- 12. PROJECT CLOSEOUT**
- 12.1 Adjustment and Clean-Up
- .1 The Sub-Contractors are responsible for maintaining site cleanliness and material management at all times.
- .2 Continuously daily cleanup equivalent to at least broom-cleaning throughout the performance of the Work within the existing building boundaries including manual clean up of waste products and debris outside the building area or on neighbouring streets.

- .3 When the Work is Substantially Performed, remove surplus products, tools, construction machinery and equipment not required for the performance of the remaining Work and leave the work clean and acceptable. Commencement of Work of any trade constitutes acceptance of conditions as being satisfactory for Work of subsequent trade. In cases of dispute, the Owner may remove the rubbish and charge the cost to the Contractor.
- .4 The Construction Manager will provide collection containers for removal of debris and deposit waste products and debris daily into the collection container. The location of collection container to be within hoarding as specified in this Section.
- .5 The Construction Manager will remove waste materials and debris from the site at regularly scheduled times.
- .6 Sub-Contractor will clean up combustible debris at end of every work day and remove from site.
- .7 Do not bury rubbish and waste materials on site.
- .8 Do not dispose of wastes or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers, ponds or ditches.
- .9 Conform to all applicable environmental laws, regulations and ordinances.
- .10 Handle, store and dispose of all hazardous wastes in compliance with authorities having jurisdiction.
- .11 Leave the work broom clean before the review process commences.

12.2 Final Cleaning

- .1 Construction Manager will:
 - .1 Perform final cleaning using experienced, professional cleaning personnel.
 - .2 Adjust, touch-up and repair all operating doors sash, hardware and equipment, leave all in perfect working order, cleaned and polished.
 - .3 Examine and clean all plumbing and electrical fixtures to produce intended appearance and function.
 - .4 Cleaning materials: Use cleaning materials that are nonhazardous.
 - .5 Wash and dry all floors and glazed walls.
 - .6 Clean and polish glass mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, mechanical and electrical fixtures. Replace broken, scratched or disfigured glass at no extra to the Contract sum if the damage occurred during the course of the Construction Contract.
 - .7 Remove stains, spots, marks, and dirt from decorative work, electrical and mechanical fixtures, furniture fittings, walls, floors and ceilings; touch-up areas with matching material/colour as required.
 - .8 Vacuum clean and dust building interiors, behind grilles, louvres and screens, including all carpeted areas, walls as well as other floors leaving in perfect condition.
 - .9 Wax, seal, shampoo or prepare floor finishes, as recommended by the manufacturer.
 - .10 Broom clean and wash exterior walks, steps and surfaces.
 - .11 Remove dirt and other disfigurements from exterior surfaces.
 - .12 Promptly and legally transport and dispose of any trash. Do not burn, bury, or otherwise dispose of trash on the Project site.

12.3 Maintenance Materials

- .1 Provide extra materials for maintenance purposes, from the same production run as installed materials, as specified in the individual specification Sections
- .2 Deliver materials to site, and place in location as designated by the Owner.

12.4 Systems Demonstrations

- .1 Prior to final review, demonstrate operation of each system to the Owner's maintenance staff. Coordinate date of demonstrations with the Owner.
- .2 All disciplines to attend the demonstrations which will take place on the same day and time.
- .3 Set up and chair the demonstrations and following disciplines are to attend, including representatives from the Owner:
 - .1 Mechanical: Mechanical Consultant, mechanical Subcontractor, HVAC Subcontractor, Plumbing Subcontractor, Controls Subcontractor, and any other Sub-Subcontractors that are relevant for operation of building.
 - .2 Electrical: Electrical Consultant, electrical Subcontractor, Electrical Sub-Subcontractors, that are relevant to the operation of the building.
- .4 Instruct personnel in operation, adjustment, and maintenance of equipment and systems, using provided operation and maintenance data as the basis for instruction.

12.5 Extended Guarantees & Warranties

- .1 In addition to the one (1) year warranty for the entire project, provide extended guarantees and warranties as specified in the individual Sections.
- .2 All guarantees and warranties are to commence on the date of Substantial Performance of the Work, in total. In the case where portions of the Work are occupied by the Owner prior to Substantial Performance of the Work, then extend guarantees and warranties that are applicable to include for the period of time prior to Substantial Performance of the Work.
- .3 Bind all guarantees and warranties into the maintenance manuals.

12.6 Review/Takeover Procedures

- .1 Refer to Owners requirements for phased hold back.

12.7 Substantial Performance of the Work

- .1 Submit written notice to the Consultant indicating when the Work of the Contract is Substantially Performed; attach a list of items to be completed or corrected, and state the time required to perform the Work as well as proposed completion date.
- .2 Allow for the Consultant together with the Owner and Construction Manager to make a review within ten (10) days after receipt of Notice of Substantial Performance of the Work.
- .3 After Substantial Performance of the Work is declared by the Construction Manager and verified by the Consultant:
 - .1 The Consultant will prepare and submit to the Construction Manager and its sub-contractors a deficiency list of items to be completed or corrected, and the time in which the Construction Manager must complete or correct the Work listed, as determined by the review.
 - .2 Prepare and issue a Certificate of Substantial Performance of the Work stating date of Substantial Performance of the Work along with the Consultant's list of items to be completed or corrected. The Consultant will not make on-going reviews of deficient work. If, after receiving notice of completion of the deficiencies and reviewing the work, the Consultant finds the work incomplete, additional reviews will be undertaken at the expense of the Construction Manager and its subcontractors.
 - .3 Complete Work listed for completion or correction, within designated time.

- .4 For work considered by Consultant not Substantially Performed:
 - .1 The Consultant will immediately notify the Contractor, in writing, stating reasons.
 - .2 Complete the Work and send second written notice to the Consultant, advising that the Work is Substantially Performed.
 - .3 The Consultant will review the Work again.
- .5 In accordance with the BUILDERS LIEN ACT, adhere to all legislation announcing Substantial Performance of the Work.

12.8 Final Review

- .1 Submit written notice to the Construction Manager indicating:
 - .1 Contract Documents have been reviewed.
 - .2 Work has been inspected for compliance with the Contract Documents.
 - .3 Work is completed and ready for final review.
- .2 Allow for the Consultant and Construction Manager to make final review within seven (7) days after the receipt of the notice, after which time the Consultant and Construction Manager will advise the date the review will be made and designate those parties required to participate.
- .3 During the review, a list of items not in accordance with Contract Documents will be compiled by the Consultant and supplied to the Construction Manager for distribution.
- .4 Proceed to correct the deficiencies and complete the Work in accordance with the Contract Documents.
- .5 When all deficiencies have been satisfactorily corrected, formally request a takeover review by the Consultant.
- .6 The Consultant will not make on-going reviews of deficient work. If, after receiving notice of completion of the deficiencies and reviewing the work, the Consultant finds the work incomplete, additional reviews will be undertaken at the expense of the Construction Manager and its sub-contractors.
- .7 After it has been agreed that the work is acceptable the Owner will take possession.

12.9 Deficiency Review

- .1 Advise the Consultant and Construction Manager when all deficiencies have been corrected and request a follow-up review.
- .2 Deficiencies must be complete prior to tenant occupancies - any deficiencies that are outstanding past tenant occupancies the subcontractor will pay for costs.
- .3 Obtain a Total Performance of the Work and Final Certificate of Payment upon completion of all deficiencies and required corrective Work from the Consultant; initiate specified follow-up reviews until Total Performance of the Work has been declared and Final Certificate of Payment has been issued.

12.10 Final Warranty Review

- .1 Prior to the expiry of the Warranty period for the project or individually completed areas of the project, carry out a review by the Consultant and the Contractor detailing the defective or unsatisfactory materials and/or workmanship. Carry out all remedial work required as observed by this review.

END OF SECTION

1. GENERAL

1.1 Intent

- .1 The intent of Delegated Design Submittals required by this section is to account for professional engineering responsibility for design, review and acceptance of components of Work forming a part of permanent Work in accordance with Building Code, and that has been assigned to a design entity other than Consultant including, but not limited to, the following:
 - .1 Design requiring structural analysis of load bearing components and connections.
 - .2 Design requiring compliance with fire safety regulations.
 - .3 Design requiring compliance with life or health safety regulations.
- .2 This section provides standard forms for submittal of Letter of Commitment and Letter of Compliance required complying with requirements of Building Code and design delegated to a professional Engineer within technical specification sections.
- .3 Delegated Design Submittals are not required for components of Work requiring engineering for temporary Work (for example: crane hoisting, engineered lifts, false Work, shoring, concrete formwork) that would normally form a part of Contractor's scope of Work.
- .4 The requirements of this section are in general conformance with recommended Responsibilities for Engineering Services for Building Projects published by Yukon Engineers, with regards to duties of specialty professionals appointed during construction period.
- .5 The requirements of this section do not diminish responsibilities of Consultant's role as Registered Professional of Record; submittals will be used by Consultant to establish that Work is substantially performed in accordance with Building Code.

1.2 Delegated Design

- .1 Performance and Design Criteria: Provide products and systems complying with specific performance and design criteria indicated where professional design services or certifications by a design professional are specifically required of Trade Contractor by Contract Documents.
- .2 If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Consultant and Construction Manager.
- .3 Delegated design will be required for elements designed by a specialty professional, which may include:
 - .1 Elements normally fabricated off-site
 - .2 Elements that require specialized fabrication equipment or a proprietary fabrication process not usually available at job site (for example: open web steel joists, wood trusses, combination wood and metal or plywood joists, prefabricated wood or metal buildings, noise and vibration isolation devices, elevators).
 - .3 Elements requiring civil engineering, not normally a part of scope of services performed by architectural; structural; mechanical; electrical; or geotechnical disciplines of Consultant (for example: structural steel connection design, steel deck design).

2. PRODUCTS

2.1 Letter of Commitment

- .1 Submit a signed and sealed Letter of Commitment on company letterhead addressed to Consultant prior to starting Work requiring design and seal of a professional engineer.

2.2 Letter of Compliance

- .1 Submit a signed and sealed Letter of Compliance on company letterhead addressed to Consultant on completion of Work requiring design and seal of a professional engineer.

3. EXECUTION

3.1 Implementation

- .1 Include summary of Work described in technical specification section as a part of the required Letter of Commitment.
- .2 Prepare required submittals and present to Consultant within sufficient time to allow for Consultant's detailed review and acceptance.

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APPENDIX A

LETTER OF COMMITMENT - **DRAFT**

Submit a signed and sealed letter of commitment on company letterhead in the form as follows:

[Date]

Stantec
[Consultant's Address]

Attention: [Consultant's Registered Professional of Record]

Re: Letter of Commitment for Delegated Design of [System of Component of Work]
[Name of Project]
[Project Number]
[City, Province]

As the retained registered professional engineer for design and field review of the above named component of Work and project, I hereby give assurance I am qualified to perform the following Work as required by Contract Documents:

1. [List appropriate design services for System or Component of Work];
2. Preparation of shop and erection documents;
3. Review fabrication of [structural] [fire rated] [life and health safety] components;
4. Review erection of [structural] [fire rated] [life and health safety] components.
5. [Modify list to suit System of Component of Work.]

I hereby give assurance that I will be responsible for above noted Work as described in Section [?????] – [Name of Section] of Project Manual, including requirements of addenda, change orders and change directives.

I also undertake to be responsible for field review of fabrication and erection of [structural] [fire rated] [life and health safety] components as required to ascertain substantial compliance with the Building Code and Contract Documents.

I will notify you in writing if my responsibility is terminated at any time during the course of Work covered by this Letter of Commitment.

Retained Professional Engineer

Signature

Date

(Apply seal)

APPENDIX B

LETTER OF COMPLIANCE - **DRAFT**

[Date]

Stantec
[Consultant's Address]

Attention: [Consultant's Registered Professional of Record]

Re: Letter of Compliance for Delegated Design of [System of Component of Work]
[Name of Project]
[Project Number]
[City, Province]

I hereby give assurance that I have fulfilled my obligations for field review as outlined by previously submitted Letter of Commitment.

I hereby give assurance that aspects of [structural] [life and health safety] Work as defined by previously submitted Letter of Commitment substantially comply with Contract Documents and Building Code.

Retained Professional Engineer

Signature

Date

(Apply seal)

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide alteration project procedures in accordance with requirements of the Contract Documents.

1.2 Definitions

- .1 Cutting: Means removal of existing construction necessary to permit installation or performance of other Work.
- .2 Make Good/Patch/Repair: Means to identify defective or damaged locations, properly prepare identified locations for repairs, and repair (including substrates) using new materials to match construction and finish of adjacent sound locations; blend repaired area smoothly with adjacent construction so that it is not distinguishable from untreated areas in performance or appearance.

1.3 Administrative Requirements

- .1 Access: Access by public to specific areas under construction will not be permitted; public and Owners access to other areas must be maintained at all times and as follows:
- .1 Provide and maintain temporary fire exit routing. Maintain clear of obstructions during full extent of Contract.
- .2 Subcontractors' access to Work shall be as later agreed by Owner, Contractor, and Consultant.
- .3 Subcontractors shall not use any facilities in existing building such as washrooms, elevator, and similar public convenience facilities without Owner's approval.
- .2 Temporary Use of Exits: Contractor shall make arrangements with Owner to use existing stairs for access to construction and renovation Work:
- .1 Required exits and exit ways shall be maintained at all times and Owner's personnel will be permitted to use stair at any time.
- .2 Protect access ways from damage during Construction. Cover wall, floor and stair surfaces with polyethylene film and cover with plywood or matting to prevent staining and scarring of existing finishes. Restore damage to condition equal to that prior to damage.
- .3 Provide temporary partitioning or enclosures to maintain or extend emergency and fire exits when required.
- .4 Provide and maintain all necessary overhead protection in public areas during progress of Work.
- .3 Scheduling: Schedules for requirements as follows:
- .1 Schedule Work and sequence operations in cooperation with Owner and Consultant. Work shall proceed in strict accordance with agreed upon and approved schedule.
- .2 Utility and service interruptions shall be kept to a minimum and will be permitted only with written permission of Owner; make requests for service interruptions at least seven (7) days before proposed date; state number of hours of interruption and confirm date and time forty eight (48) hours in advance of interruption.
- .3 Provide two (2) weeks advance notice of entering existing area of Work; confirm forty eight (48) hours in advance of starting date.
- .4 Contractor shall request written confirmation from Owner that scheduled areas of Work do not contain any equipment or furnishings that Owner intends to salvage, prior to demolition.
- .4 Responsibility and Assignment to Trades: Contractor shall assign Work of moving, removal, cutting, patching and repair to experienced and knowledgeable Subcontractors so as to cause least damage to each type of Work encountered, and so as to return building as much as possible to appearance of new Work:
- .1 Patching of finish materials shall be assigned to Subcontractors skilled in Work of finish trade involved.

- .2 Coordinate patching requirements with Section 01 00 10 – Cutting and Patching.
- .5 Coordination of Work and Noise Levels: Coordinate Owner through Consultant activities having excessive noise levels or vibration or that are detrimental to ongoing operation of existing building complex, an alternate time for such Work shall be scheduled through Consultant:
 - .1 Notify Consultant prior to commencing any Work that will cause undue noise or vibration.
 - .2 Obtain permission from Consultant prior to drilling holes or cutting chases or openings in floors or ceilings, columns or walls.
- .6 Work Areas: Limits of Work are as indicated on drawings; work and operation of machinery, storage of equipment, and materials and/or supplies, must be contained within areas under construction and as follows:
 - .1 All damage caused to existing roads, lanes, paving, curbs, buildings, and equipment due to Work of this Contract, but not called for as Work under this Contract, shall be made good by Contractor at no additional cost to Owner.
 - .2 Contact Owner's representative and arrange for sign in/sign out procedure with authorized personnel to obtain keys as required, if Contractor requires access to locked areas during construction; Return keys at end of Work period.
 - .3 Contractor shall post boundaries of working areas with suitable signs, warning his forces, that areas outside of designated Work area are out of bounds to personnel and equipment. These signs are to remain in place at all times during construction.
 - .4 Existing protected areas and other areas outside limits of Work area are out of bounds to personnel and equipment. These areas are not to be used for any other purpose.
 - .5 If revision to limits of working area becomes necessary for any compelling reason, contact Consultant immediately and do not disturb additional area without authorization from Consultant.
- 1.4 Quality Assurance
 - .1 Regulatory Requirements: Conform to Building Code, Provincial Occupational Health and Safety Act, and other applicable standards and regulations required by the Authority Having Jurisdiction including; but not limited to, the following:
 - .1 All electrical equipment and fixtures shall be CSA approved and carry appropriate CSA label.
 - .2 Use welders certified in accordance with CSA W47, and conforming to CSA W59 for structural steel work.
 - .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Matching Existing Materials: All Work performed and materials used in existing building shall be of same standard of quality as that of existing finished building as a minimum.
 - .2 Roof Patching: Make all patching, repairs, cutting, infill, and curb and flashings for new roof penetrations and openings shall be in accordance with ARCA Manual on Good Roofing Practice and Accepted Roofing Systems, using materials that are compatible with existing roof assembly.
 - .3 Fire Safety: Provide strict safety measures for welding in existing building. Provide and maintain a fully charged 9.5 kg CO₂ fire extinguisher within view and easy access of welding Work at all times.
- 1.5 Site Conditions
 - .1 Ambient Conditions: Maintain interior temperature and humidity of remainder of building during full extent of construction by installing insulated dust and weather tight non-combustible temporary partitioning as specified in Section 01 00 10 – General Requirements: Temporary Facilities.

- .2 Existing Conditions: Seal off ducts, louvers, vents, openings, or ceiling spaces between construction area and remainder of building to prevent dust, dirt, contamination, or debris from entering remainder of building:
 - .1 Provide construction filters on existing roof top units, replace as required and remove when Work is complete.
 - .2 Provide temporary partitioning and closures to contain dust and debris within immediate Work area.
 - .3 Suppress dust and dirt: Prevent occurrence of unsanitary conditions, flooding or leaking:
 - .1 Do not allow dirt, debris or discarded materials to accumulate on site; remove promptly each day.
 - .2 Keep clean, at all times, those areas adjacent to Work area to prevent dust from entering Owner's premises.
 - .3 Maintain and keep free of debris, materials and equipment, emergency and fire exits and routes.
 - .4 Provide illumination for safe demolition and working conditions, but in any case not less than 275 lx in areas where Work is being done.
 - .5 Obtain written confirmation from Owner that services to be abandoned, removed or cut have been properly and safely shut off, capped or sealed.
 - .6 Dispose of removed material legally; do not burn on site; do not allow debris to enter sewers.

2. PRODUCTS

2.1 Equipment

- .1 Provide equipment required for safe and proper demolition as indicated.

3. EXECUTION

3.1 Preparation

- .1 Confirm that Owner has removed equipment and furnishings to be salvaged, in accordance with agreed schedule.
- .2 Provide shoring and bracing as needed to keep building structurally secure and free of deflection in all its parts, and as needed for installation of new structural members.

3.2 Protection

- .1 Protect remaining finishes, equipment, and adjacent Work from damage caused by cutting, moving, removal, and patching operations. Protect surfaces that will remain a part of finished Work.
- .2 Protect existing and new Work from weather during cutting, moving, removal, and construction. Provide weather protection and other facilities and protection as needed to prevent damage to new Work and to remaining old Work.
- .3 When using a cutting torch to remove existing framing provide flame-proof screening around area of Work and cover floor area with minimum 6 mm plywood having joints taped; allow no sparks or welding or cutting spatter to fall or hit any material or finish that may be damaged or marred.
- .4 Provide protection to existing fans, motors and equipment from construction materials, dirt, dust, debris, moisture, and weld spatter.

3.3 Patching, Extending and Matching

- .1 Patch and extend existing Work using skilled mechanics that are capable of matching existing quality of workmanship. The quality of patched or extended Work shall not be less than that specified in Sections of product and execution Specifications that follow these General Requirements.

- .2 In areas where any portion of an existing finished surface is damaged, lifted, stained or otherwise made or found to be imperfect, patch or replace imperfect portion of surface with matching material.
- .3 Do not incorporate salvaged or used material in new construction, except where small quantities of finish material that are difficult to match or duplicate are approved for patching or extending purposes by Consultant.
- .4 Provide adequate support or substrate for patching of finishes.
- .5 If imperfect surface was painted or coated, repaint or recoat complete room. Confirm with Consultant.
- .6 If surrounding surface cannot be matched, repaint or recoat entire surface.
- .7 Patch and repair existing wall junctions where one wall is removed and others remain.
- .8 Where new gypsum board on metal stud construction is to align with existing construction (either plaster on concrete block or gypsum lath or existing gypsum board partitions) align construction to so there is no discontinuity between surfaces.
- .9 Skim Coating: Apply skim coating to new and existing gypsum board to areas scheduled for eggshell, semi-gloss or high gloss paints and to corridor walls and any other walls over five (5) metres in length and as follows:
 - .1 After normal gypsum board finishing but prior to priming or sealing, joints and fastener heads should be lightly sanded using a 220 mesh open weave silicon carbide sanding cloth, or wiped lightly with a damp sponge, to leave a smooth even surface covering joints and fastener heads. Caution must be taken not to raise nap of paper, if sanding.
 - .2 Mix joint compound slightly thinner than for joint taping, and apply a thin coating to entire surface with a trowel or gypsum board broad knife. Immediately wipe back to remove compound that is in excess of amount needed to fill texture differences and minor imperfections, and to eliminate laps or tool marks.
 - .3 When skim coat is completely dry, any minor ridges shall be removed by light sanding or by wiping lightly with a damp sponge.
- .10 Where new finishes are called for and existing finishes are other than paint, remove existing finishes. If in doubt, verify with Consultant prior to removal. This shall include removal of existing corner guards. Repair and make good substrate prior to installing new finishes.

3.4 Repair

- .1 Repair Work damaged in course of alterations, except at areas accepted otherwise by Consultant for other remedial action.
- .2 Where full removal of extensive amounts of almost suitable Work would be needed to replace damaged portions, then filling, straightening, spackling and similar repair techniques, followed by full painting or other finishing, may be permitted by Consultant.
- .3 Examples of Work that may frequently be approved by Consultant for repair, rather than replacement: slightly bent ceiling runners, hairline cracks in gypsum board.
- .4 If repaired Work is not brought up to standard for new Work, Consultant will direct that it be cut out and replaced with new Work.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 This Section specifies roles and responsibilities of Commissioning Training.

1.2 TRAINEES

- .1 Trainees: personnel selected for operating and maintaining this facility. Includes Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required:
- .2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

- .1 The contractor will provide:
 - .1 Descriptions of systems.
 - .2 Instruction on design philosophy, design criteria, and design intent.
- .2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
 - .1 Start-Up, operation, shut-down of equipment, components and systems.
 - .2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
 - .3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.
- .3 Contractor and equipment manufacturer to provide instruction on:
 - .1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

1.4 TRAINING OBJECTIVES

- .1 Training to be detailed and duration to ensure:
 - .1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
 - .2 Effective on-going inspection, measurements of system performance.
 - .3 Proper preventive maintenance, diagnosis and trouble-shooting.
 - .4 Ability to update documentation.
 - .5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.5 TRAINING MATERIALS

- .1 Instructors to be responsible for content and quality.
- .2 Training materials to include:
 - .1 As-Built” Contract Documents.
 - .2 Operating Manual.
 - .3 Maintenance Manual.
 - .4 Management Manual.
 - .5 TAB and PV Reports.
- .3 Project Manager, Commissioning Manager and will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 Supplement training materials:
 - .1 Transparencies for overhead projectors.
 - .2 Multimedia presentations.
 - .3 Manufacturer’s training videos.
 - .4 Equipment models.

1.6 SCHEDULING

- .1 Include in Commissioning Schedule time for training.
- .2 Deliver training during regular working hours, training sessions to be 3 hours in length.
- .3 Training to be completed prior to acceptance of facility.

1.7 RESPONSIBILITIES

- .1 Be responsible for:
 - .1 Implementation of training activities,
 - .2 Coordination among instructors,
 - .3 Quality of training, training materials,
- .2 Commissioning Authority will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Commissioning Authority.

1.8 TRAINING CONTENT

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.
- .2 Content includes:
 - .1 Review of facility and occupancy profile.

- .2 Functional requirements.
 - .3 System philosophy, limitations of systems and emergency procedures.
 - .4 Review of system layout, equipment, components and controls.
 - .5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
 - .6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
 - .7 Maintenance and servicing.
 - .8 Trouble-shooting diagnosis.
 - .9 Inter-Action among systems during integrated operation.
 - .10 Review of O&M documentation.
- .3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

1.9 VIDEO-BASED TRAINING

- .1 Manufacturer's videotapes may be used as training tool the Owner's review and written approval 3 months prior to commencement of scheduled training.
- .2 On-Site training videos:
 - .1 Videotape training sessions for use during future training.
 - .2 To be performed after systems are fully commissioned.
 - .3 Organize into several short modules to permit incorporation of changes.
- .3 Production methods to be professional quality.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes general requirements relating to commissioning (Cx) of project components and systems, specifying general requirements for performance verification (PV) of components, equipment, sub-systems, systems, and integrated systems.

1.2 ABBREVIATIONS

- .1 BMM: Building Management Manual
- .2 Cx: Commissioning
- .3 EMCS: Energy Monitoring and Control Systems
- .4 O&M: Operation and Maintenance
- .5 PI: Product Information
- .6 PV: Performance Verification
- .7 TAB: Testing, Adjusting and Balancing

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Commissioning Authority will observe some commissioning activities at their discretion.
 - .2 Owner's Performance Testing: Performance testing of equipment or systems by the University or Commissioning Authority will not relieve Contractor from compliance with specified start-up and testing procedures.
 - .3 Cooperate fully with Commissioning Authority during stages of acceptance and occupancy of facility.
 - .4 Coordination with Authorities Having Jurisdiction (AHJ):
 - .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of AHJ, arrange for authority to witness procedures to avoid duplication of tests and to facilitate an earlier acceptance of facility.
 - .2 Obtain certificates of approval, acceptance, and compliance with rules and regulations of AHJ.
 - .3 Submit copies to Consultant within 5 days of test and with Cx report.
- .2 Commissioning Meetings:
 - .1 Hold Cx meetings after project meetings as indicated in this Section.
 - .2 Use Cx meetings to resolve issues, monitor progress, and identify defects and deficiencies relating to Cx.

- .3 Continue Cx meetings on a regular basis, including during equipment start-up period, and functional testing period until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage: Commissioning Authority will request a Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Agenda topics include the following:
 - .1 Review duties and responsibilities of Contractor and Subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of Subcontractors and manufacturer's representatives in the Cx process.
- .5 Meeting will be chaired by Commissioning Authority, who will record and distribute minutes.
- .6 Ensure Subcontractors and relevant manufacturer representatives are present at [60%] construction completion stage, at subsequent Cx meetings, and when otherwise required.
- .3 Observation of Starting and Testing:
 - .1 Give 14 days notice before beginning commissioning.
 - .2 Commissioning Authority will observe start-up and testing.
 - .3 Commissioning Authority to be present at tests performed and documented by Subcontractors, suppliers, and equipment manufacturers.
- .4 Conflicts:
 - .1 Report conflicts between requirements of this Section and other Sections to Consultant and obtain interpretation or clarification before starting commissioning work.
 - .2 Failure to report conflicts and obtain interpretation or clarification will result in application of the more stringent requirement.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 – General Requirements
 - .1 Request changes to submittals in writing to Consultant and obtain written acceptance or rejection at least [8] weeks before start of Cx.
 - .2 Where Cx procedures are not specified, submit proposed ones to Commissioning Authority and obtain written acceptance or rejection at least [8] weeks before start of Cx.
 - .3 Submit additional documentation relating to Cx process as required by Commissioning Authority.
 - .4 If instruments installed in Contract will be used for Cx of TAB and PV, then submit TAB and PV instrument calibration certificates for review and acceptance.
 - .5 .Submit EMCS sensor calibration certificates.

- .2 Commissioning Schedule:
 - .1 Create and submit detailed Cx schedule as part of construction schedule.
 - .2 Allow in the schedule adequate time for Cx activities prescribed in technical specification Sections and commissioning Sections including:
 - .1 acceptance of Cx reports
 - .2 verification of reported results
 - .3 repairs, retesting, re-commissioning, and re-verification
 - .4 training
- .3 Start-Up Documentation:
 - .1 Assemble start-up documentation and submit to Commissioning Authority for review and acceptance before beginning commissioning.
 - .2 Start-up documentation to include:
 - .1 Factory and on-site test certificates for specified equipment.
 - .2 Pre-start-up inspection reports.
 - .3 Signed installation/start-up checklists.
 - .4 Start-up reports.
 - .5 Step-by-step description of complete start-up procedures so Commissioning Authority can repeat start-up at any time.
- .4 Submit for review and acceptance:
 - .1 Complete list of proposed instruments and equipment to perform commissioning.
 - .2 List data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .5 Commissioning Documentation:
 - .1 Refer to Section[01 91 13.16 - Commissioning Forms for requirements and instructions for use.
 - .2 Submit completed Cx documentation to Commissioning Authority for review and acceptance.

1.5 MAINTENANCE MATERIALS SUBMITTALS

- .1 Supply and document maintenance materials, spare parts, and special tools as specified in other specification Sections.

1.6 SITE CONDITIONS

- .1 Where Cx of weather-dependent, occupancy-dependent, or seasonally-dependent equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions if acceptable to Commissioning Authority with manufacturer's assistance in accordance with equipment manufacturer's instructions, data, and approved formulae.

Part 2 PRODUCTS

2.1 NOT USED

- .1 Not used.

Part 3 EXECUTION

3.1 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Perform Cx after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved.
- .1 Objectives: Verify that installed equipment, systems and integrated systems operate in accordance with Contract Documents and design criteria and intent.
- .2 Perform Cx throughout various seasons to calibrate and optimize systems under changing conditions.
- .3 Ensure appropriate documentation is compiled into the BMM.
- .4 Effectively train O&M staff.
- .2 Contractor shall assist in Cx process, operating equipment and systems, troubleshooting, and making adjustments as required.
- .1 Operate systems at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems should interact with each other as intended in accordance with Contract Documents and design criteria.
- .2 Make adjustments as needed, during these checks, to enhance performance and meet environmental or user requirements.
- .3 Design Criteria: In accordance with Owner's requirements or as determined by Consultant. To meet Project functional and operational requirements.

3.2 COMMISSIONING OVERVIEW

- .1 Refer to Section 01 91 13.13 - Commissioning Plan for additional Cx responsibilities.
- .2 Include Cx as a line item in Contractor's cost breakdown.
- .3 Cx activities supplement the site quality control and testing procedures described in relevant technical specification Sections.
- .4 Conduct Cx at the same time as other activities during the construction stage.
- .5 Cx identifies issues in the Design stages, which are addressed during Construction and Cx stages. This step ensures the built facility meets functional and operational requirements while operating as intended under weather, environmental and occupancy conditions. Cx activities include the transfer of critical knowledge to the Owner's facility operations personnel.

- .6 Consultant] will issue Interim Acceptance Certificate only after:
 - .1 Cx documentation has been received, reviewed for suitability, and reviewed and accepted by Commissioning Authority,
 - .2 equipment, components and systems have been commissioned, and
 - .3 O&M training has been completed.

3.3 PRE-COMMISSIONING REVIEW

- .1 Before Construction:
 - .1 Review Contract Documents and confirm in writing to Consultant the following:
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
 - .2 During Construction:
 - .1 Coordinate provision, location, and installation of provisions for Cx.
- .3 Before Beginning Cx:
 - .1 Verify Cx Plan and schedules are up-to-date.
 - .2 Verify installation of related components, equipment, systems, and sub-systems are complete.
 - .3 Review Cx requirements and procedures.
 - .4 Verify documentation used for the Cx process is shelf-ready (bound, organized, indexed, etc.).
 - .5 Review design criteria and intent, and special features to ensure full understanding.
 - .6 Submit complete start-up documentation to Commissioning Authority.
 - .7 Verify systems have been cleaned thoroughly.
 - .8 Complete TAB procedures on systems and submit TAB reports to Consultant for review and acceptance.
 - .9 Verify “As-Built” system schematics are available.
- .4 Inform Commissioning Authority in writing of defects and deficiencies in installed Work.

3.4 STARTING AND TESTING

- .1 Contractor to provide and pay costs of the following:
 - .1 inspections, including disassembly and re-assembly after approval, and for starting, testing, adjusting, and;
 - .2 temporary testing equipment.

3.5 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application Tolerances:

- .1 A specified range of acceptable deviations of measured values from specified values or specified design criteria except for special areas that shall be within +/- [10]% of specified values.
- .2 Instrument Accuracy Tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement Tolerances During Verification:
 - .1 Unless otherwise specified, actual values shall be within +/- [2]% of recorded values.

3.6 MANUFACTURER SERVICES

- .1 During factory testing, manufacturer to:
 - .1 Coordinate time and location of testing.
 - .2 Arrange for Commissioning Authority to observe testing.
 - .3 Submit testing documentation for review and acceptance by Consultant.
 - .4 Obtain written acceptance of test results and documentation from Consultant before delivery to site.
- .2 Obtain manufacturer's installation, start-up and operations instructions before start-up of components, equipment and systems, and review with Commissioning Authority.
 - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
 - .2 Modify procedures that may be detrimental to equipment performance and review with manufacturer before start-up.
- .3 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified in other divisions or where required to maintain integrity of warranty.
 - .2 Verify with manufacturer that testing as specified will not void warranties.
- .4 Qualifications of manufacturer's personnel:
 - .1 Experienced in design, installation and operation of equipment and systems.
 - .2 Ability to interpret test results accurately.
 - .3 Report results in clear, concise, logical manner.

3.7 COMMISSIONING PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in a normal and safe manner before conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in the following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, reviewed and accepted shop drawings and completion of PI report forms.

- .2 Visual inspection of quality of installation.
- .2 Start-up: Follow accepted start-up procedures.
- .3 Operational testing: Document equipment performance.
- .4 System PV: Include repetition of tests after correcting deficiencies.
- .5 Post-Substantial Performance Verification: To include fine-tuning.
- .3 Correct deficiencies and obtain acceptance from Consultant after distinct phases have been completed and before beginning the next phase.
- .4 Document required tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Consultant. If evaluation report indicates that equipment start-up procedure was deficient and resulted in equipment damage, perform the following:
 - .1 Minor equipment/systems: Perform corrective measures acceptable to Consultant.
 - .2 Major equipment/systems: If evaluation report indicates that equipment damage is minor, perform corrective measures acceptable to Consultant.
 - .3 If evaluation report indicates that major equipment damage has occurred, Consultant will reject equipment.
 - .1 Remove rejected equipment from site and replace with new equipment.
 - .2 Perform specified start-up procedures on new equipment/systems.

3.8 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

- .1 After start-up, operate and maintain equipment and systems as directed or recommended by equipment/system manufacturer.
- .2 With manufacturer's assistance, develop written maintenance program and submit to Commissioning Authority and Consultant for review and acceptance before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

3.9 TEST RESULTS

- .1 If start-up, testing, or PV produce unacceptable results, repair, replace or repeat specified starting or PV procedures until acceptable results are achieved.
- .2 Provide labour and materials, and assume costs for re-commissioning.

3.10 START OF COMMISSIONING

- .1 Notify Commissioning Authority at least [21] days before start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

3.11 TEMPORARY INSTRUMENTS AND EQUIPMENT

- .1 Provide the following instruments and equipment as required:
 - .1 [2-way radios]
 - .2 ladders
 - .3 other instruments and equipment required to complete commissioning

3.12 COMMISSIONING PERFORMANCE VERIFICATION

- .1 Carry out Cx:
 - .1 under [actual] [accepted simulated] operating conditions, over entire operating range, and in all modes, and
 - .2 on independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 Make EMCS trending information available as supporting documentation for performance verification.

3.13 EXTENT OF VERIFICATION

- .1 Laboratory areas:
 - .1 Provide labour and instrumentation to verify up to [100]% of reported results.
- .2 Elsewhere:
 - .1 Provide labour and instrumentation to verify up to [30]% of reported results, unless otherwise specified in other specification Sections.
- .3 Number and location to be at discretion of the University.
- .4 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, and instrumentation.
- .5 Review and repeat commissioning of systems if inconsistencies found in more than [20]% of reported results.
- .6 Perform additional commissioning until results are acceptable to Consultant.

3.14 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:

- .1 Accuracy complies with this specification Section.
- .2 Calibration certificates have been submitted to Commissioning Authority.
- .2 Calibrated EMCS sensors may be used to obtain performance data if sensor calibration has been completed and accepted.

3.15 PROCEDURES FOR DEFICIENCIES DISCOVERED DURING COMMISSIONING

- .1 Correct defects and deficiencies found during the Cx process. Re-verify equipment and components within the defective or deficient system to verify proper performance, including related systems if requested by Consultant].
- .2 Costs associated with re-commissioning defective and deficient work is the responsibility of Contractor. Above costs to be in the form of progress payment reductions or hold-back assessments.

3.16 COMMISSIONING CONSTRAINTS

- .1 It is necessary to complete Cx of occupancy, weather, and seasonal sensitive equipment and systems before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

3.17 MISCELLANEOUS CHECKS AND ADJUSTING

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

3.18 DEFICIENCIES AND DEFECTS

- .1 Correct deficiencies and defects found during start-up and Cx to satisfaction of Consultant.
- .2 Report concerns, deficiencies, and defects affecting Cx to Commissioning Authority in writing. Stop Cx until problems are rectified. Proceed with written acceptance from Consultant.

3.19 CLOSEOUT ACTIVITIES

- .1 Completion of Commissioning:
 - .1 Upon completion of Cx, leave systems in normal operating mode.
 - .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx before issuance of Interim Certificate of Completion.
 - .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Consultant].

- .2 Activities Upon Completion of Commissioning:
 - .1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.
- .3 Training:
 - .1 In accordance with Section [01 79 00.13 - Demonstration and Training for Building Commissioning].

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Description of overall structure of Plan and roles and responsibilities of commissioning team.

1.2 REFERENCE STANDARDS

- .1 American Water Works Association (AWWA)
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA-13- [02], Installation of Sprinkler Systems Handbook.
 - .2 NFPA-13-[02], Automatic Sprinkler Systems Handbook.
 - .3 NFPA-20-[03], Standard for the Installation of Stationary Fire Pumps for Fire Protection.
- .3 Underwriters' Laboratories of Canada (ULC)

1.3 GENERAL

- .1 Provide a fully functional facility:
 - .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
 - .2 [Facility user and] O&M personnel have been fully trained in aspects of installed systems.
 - .3 Optimized life cycle costs.
 - .4 Complete documentation relating to installed equipment and systems.
- .2 Term "Cx" in this section means "Commissioning".
- .3 Use this Cx Plan as master planning document for Cx:
 - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
 - .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
 - .3 Sets out deliverables relating to O&M, process and administration of Cx.
 - .4 Describes process of verification of how built works meet Owner requirements.
 - .5 Produces a complete functional system prior to issuance of Certificate of Occupancy.
 - .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
 - .1 Overview of Cx.

- .2 General description of elements that make up Cx Plan.
- .3 Process and methodology for successful Cx.
- .4 Acronyms:
 - .1 Cx - Commissioning.
 - .2 BMM - Building Management Manual.
 - .3 EMCS - Energy Monitoring and Control Systems.
 - .4 WHMIS Safety Data Sheets (SDS).
 - .5 PI - Product Information.
 - .6 PV - Performance Verification.
 - .7 TAB - Testing, Adjusting and Balancing.
 - .8 WHMIS - Workplace Hazardous Materials Information System.
- .5 Commissioning terms used in this Section:
 - .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
 - .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF 100% CX PLAN

- .1 Cx Plan to be 95% completed before added into Project Specifications.
- .2 Cx Plan to be 100% completed within 8 weeks of award of contract to take into account:
 - .1 Approved shop drawings and product data.
 - .2 Approved changes to contract.
 - .3 Contractor's project schedule.
 - .4 Cx schedule.
 - .5 Contractor's, sub-contractor's, suppliers' requirements.
 - .6 Project construction team's and Cx team's requirements.
- .3 Submit completed Cx Plan to Consultant and obtain written approval.

1.5 REFINEMENT OF CX PLAN

- .1 During construction phase, revise, refine and update Cx Plan to include:
 - .1 Changes resulting from Client program modifications.
 - .2 Approved design and construction changes.
- .2 Revise, refine and update every 6 [months during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Consultant for review and obtain written approval.
- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

- .1 The Owner to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 Project Manager will select Cx Team consisting of following members:
 - .1 Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and O&M personnel.
 - .4 Monitoring of Cx activities, training, development of Cx documentation.
 - .5 Work closely with members of Cx Team.
 - .6 Monitoring operations Cx activities.
 - .7 Witnessing, certifying accuracy of reported results.
 - .8 Witnessing and certifying TAB and other tests.
 - .9 Developing BMM.
 - .10 Ensuring implementation of final Cx Plan.
 - .11 Performing verification of performance of installed systems and equipment.
 - .12 Implementation of Training Plan.
 - .2 Construction Team: contractor, subcontractors, suppliers and support disciplines, is responsible for construction/installation in accordance with Contract Documents, including:
 - .1 Testing.
 - .2 TAB.
 - .3 Performance of Cx activities.
 - .4 Delivery of training and Cx documentation.
 - .5 Assigning one person as point of contact with Consultant and PWGSC Cx Manager for administrative and coordination purposes.
 - .3 Contractor's Cx agent implements specified Cx activities including:
 - .1 Demonstrations.
 - .2 Training.
 - .3 Testing.
 - .4 Preparation, submission of test reports.
 - .4 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.
 - .2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

- .1 Employ the following Cx participants to verify performance of equipment and systems:
 - .1 Installation contractor/subcontractor:
 - .1 Equipment and systems except as noted.
 - .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
 - .1 To include performance verification.
 - .3 Specialist subcontractor: equipment and systems supplied and installed by specialist Specialist Cx agency:
 - .1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.
 - .4 Client: responsible for intrusion and access security systems.
 - .5 Ensure that Cx participant:
 - .1 Could complete work within scheduled time frame.
 - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O&M personnel, including:
 - .1 Modify ventilation rates to meet changes in off-gassing.
 - .2 Changes to heating or cooling loads beyond scope of EMCS.
 - .3 Changes to EMCS control strategies beyond level of training provided to O&M personnel.
 - .4 Redistribution of electrical services.
 - .5 Modifications of fire alarm systems.
 - .6 Modifications to voice communications systems.
 - .6 Provide names of participants to Commissioning Authority and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Cx for review and approval.

1.8 RISK ASSESSMENT

- .1 Project manager to assess and maintain a risk register.

1.9 EXTENT OF CX

- .1 Commission mechanical systems and associated equipment:
 - .1 Existing Mechanical Systems – Energy Centre:
 - .1 The boiler flue gas heat recovery system includes a flue gas economizer, variable speed fan, boiler flue control dampers, temperature and flow sensors, and a dedicated PLC-type controller.

- .2 Backup/emergency heating heat exchanger with manual valves for flow through a heat exchanger and a modulating temperature-controlled and control valve for temperature control.
- .2 Mechanical Systems – Polaris Building:
 - .1 Process Chilled Water Plant, including.
 - .1 Chillers
 - .2 Chilled water pumps and associated VFD's
 - .3 Waste heat recovery heat pump and source/load side pumps
 - .3 Plumbing systems:
 - .1 Plumbing fixtures
 - .2 Safety showers
 - .3 Eyewash stations
 - .4 Water temperature mixing systems.
 - .5 Domestic water heating equipment
 - .6 Domestic hot water recirculation systems
 - .7 Drainage systems
 - .8 Acid neutralization systems
 - .9 Backflow prevention equipment
 - .10 Specialty Plumbing Systems
 - .11 Lab reverse osmosis water distribution
 - .12 Lab vacuum source equipment
 - .13 Lab vacuum delivery systems, including inlet points and separators
 - .4 HVAC and exhaust systems:
 - .1 Air handling units including all components including
 - .1 Fans
 - .2 Coils
 - .3 Filters (all stages including pre, mid and final)
 - .4 Heat recovery devices (including enthalpy wheels, fluid run-around)
 - .5 Heating and cooling coils
 - .6 Pre-heating coils
 - .7 Isolation dampers
 - .8 Control dampers
 - .9 Airflow measurement stations
 - .10 VFDs
 - .11 General exhaust systems
 - .12 Exhaust systems and related systems
 - .13 Laboratory fume hoods and related systems.

- .14 Energy recovery systems
- .15 Specialized lab exhaust systems
- .16 Airside zone terminal control units including
- .17 Zone supply terminal units
- .18 Zone exhaust terminal units
- .19 Fume hood airflow control valves
- .20 Lab specialty exhaust hood control valves
- .21 Lab supply air control valves
- .22 Room pressure control systems
- .23 Room pressure monitors
- .24 Room pressure controllers
- .25 Water side zone terminal units including controls
- .26 Zone perimeter heating units
- .27 Ventilation system reheat units and cooling units
- .28 Zone Air-conditioning units
- .5 Fire and life safety systems:
 - .1 Special fire suppression systems
 - .2 Fire pumps, including transfer switches and controllers.
 - .3 Wet pipe sprinkler systems.
 - .4 Dry pipe sprinkler systems.
 - .5 Standpipe and hose systems.
 - .6 Total flooding fire extinguishing systems.
 - .7 Fire extinguishers.
- .6 Noise and vibration control systems for mechanical systems.
- .7 EMCS:
 - .1 Systems and equipment operation sequences for normal operation and failure modes
 - .1 All physical points and end devices including:
 - .1 Valves
 - .2 Dampers
 - .3 Temperature sensors
 - .4 Humidity sensors
 - .5 Air quality sensors
 - .6 Occupancy sensors
 - .7 Meters for various HVAC and plumbing system usage and/or consumption, including energy
 - .8 Operator workstation graphics

- .2 Coordination, supervision, and quality control monitoring of HVAC testing, adjusting and balancing Contractor
- .2 Energy metering systems for hot water, chilled water, [electricity].
- .2 Commission electrical systems and equipment:
 - .1 Normal Power Distribution System – The Energy Centre:
 - .1 Motor control system interface with BMS
 - .2 120/208V CDP and branch circuit panels
 - .3 600V mechanical panel
 - .2 Normal Power Distribution System – Polaris:
 - .1 Switchgear breakers and components
 - .2 600V CDP panels
 - .3 Motor control system interface with BMS
 - .4 600-120/208V indoor dry-type transformers
 - .5 120/208V CDP and branch circuit panels
 - .3 Emergency/Standby/UPS Power Distribution System :
 - .1 Diesel fueled generator
 - .2 Diesel fuel storage and fuel delivery system
 - .3 Switchgear breakers and components
 - .4 Automatic transfer switch
 - .5 600V CDP panels
 - .6 Motor control system interface with BMS
 - .7 600-120/208V indoor dry type transformers
 - .4 Life Safety Systems:
 - .1 Fire alarm system including interface with existing campus system
 - .2 Mass notification system including interface with campus system
 - .3 Emergency lighting system
 - .4 Exit lighting system
- .3 Lighting systems:
 - .1 Interior and exterior lighting fixtures
 - .2 Digital lighting control system
 - .3 Daylight harvesting
 - .4 Dimming control
 - .5 Occupancy control
 - .6 Scheduled on/off control
 - .7 Circadian lighting control
- .4 Fire alarm systems, equipment:
 - .1 Annunciators.

- .2 Control panels.
- .3 Fire alarm battery banks.

- .5 Access Control System:
 - .1 Intrusion and access security and safety systems as follows:
 - .1 Interface with existing campus access control system
 - .2 Confirm system operation
 - .3 Access Control System
 - .4 Access control to building and secured building areas
 - .5 Integration with existing campus access control system
 - .6 CCTV System
- .6 Integrated Systems Testing:
 - .1 Internal and external building monitoring
 - .2 Integration with fire alarm speaker system including interface with existing campus system
 - .3 Integration with Emergency power generation systems
 - .4 Integration with Emergency lighting system
 - .5 Integration with Special fire suppression systems
 - .6 Integration with Fire pumps, including transfer switches and controllers.

1.10 DELIVERABLES RELATING TO O&M PERSPECTIVES

- .1 General requirements:
 - .1 Compile English documentation.
 - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
 - .1 Warranties.
 - .2 Project record documentation.
 - .3 Inventory of spare parts, special tools and maintenance materials.
 - .4 Maintenance Management System (MMS) identification system used.
 - .5 WHMIS information.
 - .6 WHMIS Safety Data Sheets (SDS).
 - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

1.11 DELIVERIES RELATING TO THE CX PROCESS

- .1 General:
 - .1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.
- .2 Definitions:
 - .1 Cx as used in this section includes:
 - .1 Cx of components, equipment, systems, subsystems, and integrated systems.
 - .2 Factory inspections and performance verification tests.
- .3 Deliverables: provide:
 - .1 Cx Specifications.
 - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed installation checklists (ICL).
 - .4 Completed product information (PI) report forms.
 - .5 Completed performance verification (PV) report forms.
 - .6 Results of Performance Verification Tests and Inspections.
 - .7 Description of Cx activities and documentation.
 - .8 Description of Cx of integrated systems and documentation.
 - .9 Training Plans.
 - .10 Cx Reports.
 - .11 Prescribed activities during warranty period.
- .4 Commissioning Authority to witness and certify tests and reports of results provided to Consultant & Owner.

1.12 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Items listed in this Cx Plan include the following:
 - .1 Pre-Start-Up inspections: prior to permission to start up and rectification of deficiencies to Consultant's satisfaction.
 - .2 Contractor to use approved check lists.
 - .3 Commissioning Authority will monitor some of these pre-start-up inspections.
 - .4 Include completed documentation with Cx report.
 - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Consultant as required and does not form part of Cx specifications.
 - .6 Commissioning Authority will monitor some of these inspections and tests.
 - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - MECHANICAL:

- .1 Plumbing systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 Complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
- .2 HVAC equipment and systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 At this time, complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .4 Perform TAB on systems. TAB reports to be approved by Consultant.
- .3 EMCS:
 - .1 EMCS trending to be available as supporting documentation for performance verification.
 - .2 Perform point-by-point testing in parallel with start-up.
 - .3 Carry out point-by-point verification.
 - .4 Demonstrate performance of systems, to be witnessed by Commissioning Authority prior to start of 30-day Final Acceptance Test period.
 - .5 Perform final Cx and operational tests during demonstration period and 30-day test period.
 - .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".
- .3 Pre-Cx activities - LIFE SAFETY SYSTEMS
 - .1 Include equipment and systems identified above.
- .4 Pre-Cx activities - ELECTRICAL:
 - .1 High voltage distribution systems over 750 V:
 - .1 Requires independent testing agency to perform pre- energization and post-energization tests.
 - .2 Low voltage distribution systems under 750 V:
 - .1 Requires independent testing agency to perform pre- energization and post-energization tests.
 - .3 Emergency power generation systems
 - .1 Transfer switches: test by simulating loss of power. Verify availability of power at equipment requiring same.
 - .2 Uninterruptible power systems: test under full and partial load conditions.
 - .4 Lighting systems:
 - .1 Emergency lighting systems:

- .1 Tests to include verification of lighting levels and coverage, initially by disrupting normal power.
- .5 Fire alarm systems: test after other safety and security systems are completed. Testing to include a complete verification in accordance with ULC requirements. Consultant has witnessed and certified report, demonstrate devices and zones to Consultant.
- .6 Low voltage systems: these include:
 - .1 Clock, communications, low voltage lighting control systems and data communications systems.
- .7 Security, surveillance and intrusion alarm systems: to include verification by Commissioning Authority.

1.13 START-UP

- .1 Commissioning Authority to monitor all of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Consultant.
- .2 Performance Verification (PV):
 - .1 Approved Cx Agent to perform.
 - .1 Repeat when necessary until results are acceptable to Consultant.
 - .2 Use procedures modified generic procedures to suit project requirements.
 - .3 Commissioning Authority to witness and certify reported results using approved PI and PV forms.
 - .4 Commissioning Authority to review completed PV reports and provide to Consultant.
 - .5 The University reserves right to verify up to 30% of reported results at random.
 - .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.14 CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Perform Cx by specified Cx agency using procedures developed by Commissioning Authority and approved by Consultant.
- .2 Commissioning Authority to monitor Cx activities.
- .3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.
- .4 Commissioning Authority to witness, certify reported results of, Cx activities and forward to Consultant.

1.15 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

- .1 Cx to be performed by specified Contractor, using procedures developed by Commissioning Authority and approved by Consultant.

- .2 Tests to be witnessed by Commissioning Authority and documented on approved report forms.
- .3 Upon satisfactory completion, Commissioning Authority to prepare and certify Cx Report, and submit to Consultant for review.
- .4 The University reserves right to verify percentage of reported results.
- .5 Integrated systems to include:
 - .1 HVAC and associated systems forming part of integrated HVAC systems
 - .2 Smoke control systems
 - .3 Fire alarm systems
 - .4 Fire pumps and controllers
 - .5 Voice communications systems
 - .6 Emergency power generator
 - .7 Transfer switch and controllers
 - .8 Emergency lighting systems

1.16 INSTALLATION CHECK LISTS (ICL)

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms].

1.17 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Refer to Section [01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.18 PERFORMANCE VERIFICATION (PV) REPORT

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.19 DELIVERABLES RELATING TO ADMINISTRATION OF CX

- .1 General:
 - .1 Because of risk assessment, complete Cx of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

1.20 CX SCHEDULE

- .1 Prepare Cx Schedule and submit to Consultant for review and approval same time as project Construction Schedule. Include:
 - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
 - .1 Design criteria, design intents.

- .2 Pre-TAB review: [28]days after contract award, and before construction starts.
- .3 Cx agents' credentials: [60] days before start of Cx.
- .4 Cx procedures: [3] months after award of contract.
- .5 Cx Report format: [3] months after contract award.
- .6 Discussion of heating/cooling loads for Cx: [3] months before start-up.
- .7 Submission of list of instrumentation with relevant certificates: [21] days before start of Cx.
- .8 Notification of intention to start TAB: [21] days before start of TAB.
- .9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
- .10 Notification of intention to start Cx: [14] days before start of Cx.
- .11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed [14] days before start of integrated system Cx.
- .12 Identification of deferred Cx.
- .13 Implementation of training plans.
- .14 Cx of smoke management/control systems: after Cx of related systems is completed and [7] days before proposed date of Cx these systems.
- .15 Cx reports: immediately upon successful completion of Cx.
- .16 Emergency evacuation exercises: after [80]% occupancy [and at same time as Cx of stair shaft pressurization systems].
- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.
- .3 [6] months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Consultant, Contractor, Contractor's Cx agent, and Consultant will monitor progress of Cx against this schedule.

1.21 CX REPORTS

- .1 Submit reports of tests, witnessed, and certified by Commissioning Authority who will verify reported results.
- .2 Include completed and certified PV reports in properly formatted Cx Reports.
- .3 Before reports are accepted, reported results to be subject to verification by Commissioning Authority.

1.22 ACTIVITIES DURING WARRANTY PERIOD

- .1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:

- .1 Fine tuning of HVAC systems.
- .2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.
- .3 Full-scale emergency evacuation exercises.

1.23 TESTS TO BE PERFORMED BY OWNER/USER

- .1 None is anticipated on this project.

1.24 TRAINING PLANS

- .1 Refer to Section 01 79 00.13 - Demonstration and Training for Building Commissioning.

1.25 FINAL SETTINGS

- .1 Upon completion of Cx to satisfaction of the Consultant lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Commissioning forms to be completed for equipment, system and integrated system.

1.2 INSTALLATION/START-UP CHECK LISTS

- .1 Include the following data:
 - .1 Product manufacturer's installation instructions and recommended checks.
 - .2 Special procedures as specified in relevant technical sections.
 - .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Commissioning Authority, supplemental additional data lists will be required for specific project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Commissioning Authority. Check lists will be required during Commissioning and will be included in Building Maintenance Manual (BMM) at completion of project.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the BMM at completion of work.
- .2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Consultant's approval.

1.4 PERFORMANCE VERIFICATION (PV) FORMS

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.

- .2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.
- .3 Prior to PV of integrated system, complete PV forms of related systems and obtain Commissioning Authority's approval.

1.5 SAMPLES OF COMMISSIONING FORMS

- .1 Commissioning Authority will develop and provide to Contractor required project-specific Commissioning forms in electronic format complete with specification data.
- .2 Revise items on Commissioning forms to suit project requirements.
- .3 Samples of Commissioning forms and a complete index of produced to date will be attached to this section.

1.6 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

- .1 When additional forms are required, but are not available from Commissioning Authority develop appropriate verification forms and submit to Commissioning Authority for approval prior to use.
 - .1 Additional commissioning forms to be in same format as provided by Commissioning Authority

1.7 COMMISSIONING FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Commissioning Authority provides Contractor project-specific Commissioning forms with Specification data included.
 - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
 - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
 - .6 Record analytical and substantiating data.
 - .7 Verify reported results.
 - .8 Form to bear signatures of recording technician and reviewed and signed off by Commissioning Authority.
 - .9 Submit immediately after tests are performed.
 - .10 Reported results in true measured SI unit values.
 - .11 Provide Commissioning Authority with originals of completed forms.
 - .12 Maintain copy on site during start-up, testing and commissioning period.

- .13 Forms to be both hard copy and electronic format with typed written results in Building Management Manual.

1.8 LANGUAGE

- .1 To suit the language profile of the awarded contract.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 GENERAL INSTRUCTIONS

- .1 Read and conform to:
 - .1 Section 01 91 13 - Facility Commissioning - General
 - .2 Section 01 91 15 - Facility Commissioning - Electrical
 - .3 Comply with Division 1 requirements and documents referred to herein.

1.2 SYSTEMS TO BE COMMISSIONED

- .1 Refer to Section 01 91 13.13 Commissioning Plan

1.3 DOCUMENTATION

- .1 Contractor shall complete installation verification and equipment start-up forms and submit the forms together with copies of test certificates to Consultant and Commissioning Authority for review and approval.

1.4 COMMISSIONING PROCESS

- .1 Commissioning Authority: to perform and complete all work as specified in the "GENERAL" Section of this specification "Responsibilities of Commissioning Authority".
- .2 Contractors: To perform and complete all works as specified in the "GENERAL" Section of this specification "Responsibilities of Contractor". In general, it shall include complete activation of all systems; calibration, test, and verification of performance of all components, equipment and systems; verification of performance of all systems through all specified modes of control and sequence of operation along with simulated reasonable operational situations; rectification of deficiencies; recording of test results for submission; demonstration, instruction and training of Owner's operating and maintenance personnel; follow-up during first year of operation for fine tuning and building service monitoring.
- .3 Equipment verification: Contractor shall test and verify proper operation of all equipment and systems prior to start of commissioning and record all results from the test for each piece of equipment. Forms shall be included in the Operating and Maintenance Manual. Equipment data shall include, but is not limited to:
 - .1 manufacturer's name, address and telephone number;
 - .2 distributors' name, address and telephone number;
 - .3 make, model number and serial number;
 - .4 pumps – type, RPM, impeller sizes, rated flow;
 - .5 fans – belt type and size, sheave type and size;

Part 2 Testing Equipment

2.1 GENERAL

- .1 Contractor and manufacturer shall provide all instrumentation and test equipment necessary to conduct the tests specified during the commissioning process. Contractor shall submit a list of equipment to be used and copies of latest equipment calibration certificates to the Commissioning Authority and Consultant for review and comments.

2.2 MECHANICAL TESTING EQUIPMENT:

- .1 Following equipment shall be provided but not limited to:
 - .1 pressure measurements: manometers, pressure gauges, digital pressure readers, pressure trending devices;
 - .2 temperature measurements: thermometers, digital thermometers, thermocouples, temperature trending devices;
 - .3 velocity measurement: pitot tube, propeller or revolving vane manometer, thermo anemometers, hot wire anemometers;
 - .4 volume or mass flow measurement: venturi, nozzle and orifice flowmeter, positive displacement meter;
 - .5 rotative speed: tachometer;
 - .6 combustion analysis: flue gas analysis;
 - .7 sound measurement: electronic sound level meter for acoustic measurement with octave band analysis;
 - .8 vibration measurement: accelerometer;
 - .9 recording: chart recorder;
 - .10 electrical measurements: voltmeter, ammeter and wattmeter;
 - .11 Any other equipment specified by the manufacturer to perform required testing and verification.

Part 3 Testing for Mechanical Systems

3.1 PLUMBING AND DRAINAGE SYSTEM TESTING:

- .1 Plumbing and drainage system shall be tested in accordance with the Plumbing Code under the Saskatchewan Plumbing Code.
- .2 Contractor shall notify Building Inspector when systems are available for testing. Contractor shall document all tests performed and shall arrange for Building Inspector to sign for tests completed. Forward forms to Consultant and Commissioning Authority for review.
- .3 When the plumbing system has been completed take a sample of the drinking water, in the presence of the Consultant. Forward the sample to a testing laboratory which shall be approved by the Consultant. Forward the test results to the Consultant and Commissioning Authority. Include for all cost of water analysis.

- .4 Perform hydrostatic pressure test and system flush and disinfection for domestic hot and cold water systems as per the requirements of the mechanical specification.

3.2 WATER TREATMENT SYSTEMS:

- .1 Contractor shall employ a Chemical Treatment Specialist who shall assist the Contractor with selection of the chemical treatment system, inspect the installation and test the system. Specialist shall complete manufacturers' testing forms and submit a report to the Consultant and the Commissioning Authority for review and comments. Review chemical treatment specialist selection with Owner's Representative.
- .2 Specialist shall assist Contractor to clean all piping systems. Specialist shall take samples and repeat the cleaning process if specification requirements are not met.
- .3 Specialist shall assist Contractor and add chemical immediately after the cleaning process for each system for protection. The specialist shall take samples and repeat the process until specification requirements are met.
- .4 Specialist shall revisit the site after 1 month of operation of each system and re-test systems.

3.3 CONTRACTOR'S TESTING OF PIPING SYSTEMS

- .1 applicable to, hydronic circulation, domestic hot and cold water and condensate.
- .2 Test all piping systems in accordance with all applicable Codes.
- .3 All other systems not covered by Codes noted above shall be tested and proven tight over a period of 24 hours by a hydrostatic test. Remove fixtures, appliances, devices, vents and gauges and temporarily plug connections as required. Provide temporary by-pass when required. Protect equipment not capable of withstanding test pressure during testing.
- .4 Repair any leaks or defects and repeat the tests to the satisfaction of the Consultant.
- .5 After completion of the testing, rough balance the water systems and ensure all coils, converters, etc., are operating approximately to the design conditions to ensure freezing conditions will not occur anywhere. Adjust the circuits by means of the balancing valves.
- .6 Where multiple branch, domestic hot recirculation or drinking fountain chilled water lines are installed, the flow in these shall be balanced to ensure hot or chilled water, as applicable, at all fixtures.
- .7 All tests for the systems shall be witnessed. Complete the testing forms and forward copies of the tests reports to the Consultant and Commissioning Authority for review and comments.
- .8 Co-ordinate with TAB Contractor to ensure all necessary valves required for balancing the system are installed.
- .9 Notify Consultant and Commissioning Authority in writing that this co-ordination has taken place before installation begins. If Contractor fails to co-ordinate with TAB Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by Contractor at no cost to Owner.

- .10 Ensure all cooling coil drain pans drain freely and that no standing water remains.
- .11 Ensure access is provided to all valves and equipment that requires servicing.
- .12 Contractor is responsible for all equipment operating to design conditions and shall trim impellers, etc., to provide the required conditions, but is not responsible for the final balancing of the system, which shall be carried out by TAB Contractor. Final verification of balancing to be coordinated by the TAB Contractor and witnessed/verified by the Commissioning Authority.
- .13 Contractor shall make available staff at no extra cost to Owner, as required by TAB Contractor, to correct any deficiencies in the mechanical systems which prevent TAB Contractor from balancing the system.
- .14 Contractor shall provide copies of all shop drawings requested by TAB Contractor.

3.4 THE INDEPENDENT TESTING AND BALANCING CONTRACTOR'S BALANCING OF HYDRONIC WATER SYSTEM AND GLYCOL HYDRONIC SYSTEMS:

- .1 Contractor shall follow the requirements as described in specification 23 05 93.

3.5 CONTRACTOR'S TESTING OF AIR DISTRIBUTION SYSTEMS:

- .1 Contractor shall test for air leakage in accordance with SMACNA Manuals and Standards, all ductwork with the exception of ductwork downstream of variable air volume boxes or other pressure reducing devices. Seal ducts at all equipment connections and pressurize with a smaller blower. Test methods and results shall be in compliance with HVAC air duct leakage test manuals of SMACNA. In addition, seal any leaks. Test system as a whole or in parts, provided all ductwork is accessible for inspection at the time of test. Provide blower, calibrated orifice tube and all test equipment. (The inlet opening of the test blower shall be blocked off before the test blower is started. The inlet opening shall then be opened slowly to prevent over-pressurizing the system). Refer to the specifications for the criteria for leakage evaluation and for the definition of acceptable test results.
- .2 Refer to specification Section related to Ductwork and Specialties for pressure ratings of ductwork and systems.
- .3 Entire system shall be tested for noise, tightness of joints and proper functioning of the system. Noise tests shall be made under minimum system pressure drop conditions (highest air velocities and clean filter conditions). This section shall make all necessary alterations and repeat the tests until satisfactory operation is achieved.
- .4 All tests shall be performed in presence of Consultant. Complete the testing forms and forward to Consultant and Commissioning Authority for review and comments.
- .5 Adjust minimum outside air controller and adjust return air and exhaust air damper linkages to approximately design air quantities, for both maximum and minimum conditions where required, to ensure freezing conditions will not occur.
- .6 Co-ordinate with TAB Contractor to ensure all necessary manual dampers and splitter dampers for balancing the system are installed. Notify Consultant in writing that this co-ordination has taken place before installation begins. If this Contractor fails to co-ordinate with TAB Contractor and if failure to co-ordinate results in being unable to

balance the systems, the cost of any changes required shall be paid for by Contractor at no cost to Owner.

- .7 The testing equipment shall be itemized in the test reports and shall be approved by the Consultant before any tests are undertaken. Calibration of the test equipment must be submitted, confirmed, and approved by the Consultant before any tests are undertaken.
- .8 Ensure access is provided to all fire dampers and equipment that require servicing. Fire damper operation to be verified by the Commissioning Authority with, and coordinated by, the Contractor.
- .9 Contractor is responsible for all equipment operating to design conditions and shall change fan sheaves, etc., to provide the required conditions, but is not responsible for the final balancing of the system.
- .10 Contractor shall make available staff, as required by TAB Contractor, to correct any deficiencies in mechanical systems which prevent TAB Contractor from balancing system.
- .11 Contractor shall provide copies of all shop drawings requested by TAB Contractor.
- .12 Contractor shall provide access ports for balancing as requested by TAB Contractor.

3.6 THE INDEPENDENT TESTING AND BALANCING CONTRACTOR'S BALANCING OF AIR SYSTEMS:

- .1 Contractor shall follow the requirements as described in specification 23 05 93.

3.7 TESTING OF HVAC AND SPECIALTIES EQUIPMENT AND SYSTEMS:

- .1 Contractor shall prepare and submit for approval, Commissioning Plan and schedule which includes:
 - .1 detailed schedule for all individual testing activity. The detail shall include the steps to be taken sequentially and indicate which conditions should be observed and recorded;
 - .2 the status of systems to be able to perform tests;
 - .3 required testing equipment;
 - .4 Manufacturers' commissioning time for all systems and equipment;
 - .5 required time for remedial works if necessary;
 - .6 staged start-up and commissioning of the systems.
- .2 Start-up and test procedures must be consistent with manufacturer's recommendations contained in the Operating and Maintenance Manual.
- .3 The start-up report shall record all observations made during the start-up procedures including problems and their resolutions.
- .4 Contractor shall retain the services of the manufacturer's technicians to test the equipment and associated systems as follows:
 - .1 Technician shall record the results of the tests on the testing forms. The tests shall be witnessed by Consultant.

- .2 When tests have been completed satisfactorily the technician and witnessing authority shall sign the forms.
- .3 A copy of the forms shall be forwarded to the Consultant and Commissioning Authority for review and comments.
- .4 The original shall be inserted into the System Description Manual.
- .5 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made.
 - .1 The additional tests shall be witnessed by the Consultant and the Commissioning Authority.
- .6 Tests which have not been witnessed shall not be accepted and shall be repeated.
- .5 Equipment and systems to be tested shall include but not limited to the following wherever applicable:
 - .1 heat pump;
 - .2 heating and cooling distribution systems;
 - .3 air handling systems;
 - .4 humidification systems;
 - .5 Building Automation and Controls Systems;

3.8 AIR HANDLING SYSTEMS:

- .1 Air handling units shall be inspected and tested by manufacturer's technician. Technician shall enter the test results on forms provided by manufacturer. The Consultant shall witness the final operational test.
- .2 Technician shall verify that the air handling units have been installed according to manufacturer's recommendations, shop drawings and the specification.
- .3 Tests shall include verification of electrical power, electrical interlocks, safeties, control, coil valves, fans and dampers.
- .4 Technician shall start-up the air handling unit and monitor the operation for a minimum of 4 hours of running time after all tests have been completed. Technician shall issue a report to Consultant after completion.
- .5 Air handling unit manufacturer shall co-ordinate with BAS Contractor to provide the necessary interface to the Building Automation and Controls Systems. Technician shall witness the Building Automation and Controls Systems testing procedure for the air handling unit and sign the testing forms.
- .6 Contractor shall rectify any deficiencies identified by TAB Contractor.

3.9 HUMIDIFICATION SYSTEM:

- .1 Humidifiers shall be inspected and tested by manufacturer's technician. Technician shall enter the test results on the forms provided by manufacturer. Consultant shall witness the final operational test.

- .2 Technician shall verify humidifiers have been installed according to manufacturer's recommendations, shop drawings and the specification.
- .3 Tests include verification of safeties and control, drains, steam piping and insulation, steam nozzles and distribution.
- .4 Technician shall start-up the humidifiers, record and monitor their operation for a minimum of 4 hours running time after the tests have been completed. Reports shall be forwarded to Consultant after completion.
- .5 Manufacturer shall co-ordinate with BAS Contractor to provide necessary interface to the Building Automation and Controls Systems. Technician shall witness the Building Automation and Controls Systems testing procedure and control of the humidifiers.

3.10 CHILLED WATER, HEATING WATER AND HEAT PUMP SYSTEM:

- .1 The heat pumps and pumping systems shall be inspected and tested by the Manufacturers' Technician. The Technician shall enter the test results on forms provided by manufacturer. Consultant shall witness the final operational test.
- .2 Technician shall verify heat pumps, heat exchangers and pumps have been installed according to manufacturer's recommendations, shop drawings and the specification.
- .3 Tests include verification of electrical power, electrical interlocks, safeties, equipment performance and controls.
- .4 Technician shall start-up the heat pump and monitor the operation for a minimum of 4 hours of running time after all tests have been completed. Technician shall issue a report to Consultant after completion.
- .5 Heat Pump manufacturer shall co-ordinate with BAS Contractor to provide the necessary interface to the Building Automation and Controls Systems. Technician shall witness the Building Automation and Controls Systems testing procedure for the chillers and cooling tower and sign the testing forms.
- .6 Heat exchangers and pumps shall be inspected and tested by manufacturer's technician. Technician shall enter the test results on forms provided by manufacturer. Consultant and Commissioning Authority shall witness the final operational test.

3.11 BUILDING AUTOMATION AND CONTROLS SYSTEMS:

- .1 The Building Automation and Controls Systems shall be fully tested and commissioned by manufacturer's technician to operate in the manner defined by the specifications.
- .2 BAS Contractor shall provide a print-out of general and critical alarm lists and all points connected to the Building Automation and Controls Systems. The all point log shall be sub-divided into points per system. One report shall be taken prior to the acceptance test.
- .3 BAS Contractor shall provide an operating terminal and sufficient training and instruction to TAB Contractor which will allow them to set-up and balance the water and air systems.
- .4 A point-to-point testing shall be done by BAS Contractor. This test shall include, but is not limited to:

- .1 ensuring that wiring is accurately connected to appropriate terminals;
 - .2 checking the function of each control and controlled device (such as the beginning, end and extent of actuator travel);
 - .3 connection integrity between actuator and device;
 - .4 calibration of sensors;
 - .5 output from sensors;
 - .6 operation of relays;
 - .7 data/information integrity at console;
 - .8 remote reset integrity from console to field device;
 - .9 interfacing with other systems such as life safety monitoring system.
 - .10 BAS contractor in conjunction with the mechanical contractor shall create simulated design load conditions for control verification tests.
- .5 Testing procedure shall include but is not limited to:
- .1 check and verify that each input point is reporting to the Building Automation and Controls Systems panels and workstations in the normal state and change or state;
 - .2 create false alarms at each point and provide a print-out of the test;
 - .3 command each output point, via the workstation and verify the action at the device;
 - .4 verify that each time of day and optimum start program is operational in software and at the device;
 - .5 verify that each program is operational in software and at the device(s);
 - .6 verify that each system graphic is dynamically updating;
 - .7 test each DDC loop and verify that it is controlling in a stable manner. Create set point changes on output points. False loads shall be introduced to observe the control loops response. Program trend logs at the Building Automation and Controls Systems for a minimum of 30 minutes per control loop with a sampling time of 30 seconds. Provide a print-out of the results. Tune each DDC loop prior to acceptance test. Check each loop again, once during the heating and once during the cooling season and re-tune where necessary;
 - .8 verify that each report type is functional;
 - .9 verify that each global program that controls more than 1 system is operating;
 - .10 verify that all safeties are operating (ie. firestats);
 - .11 verify valve and damper actuation;
 - .12 verification of the minimum and maximum settings on VAV boxes;
 - .13 verify the calibration of each analog input point.
- .6 Any sensor disconnected from the input terminal after completion of the performance test shall be retested.
- .7 BAS Contractor shall provide a "signed-off" copy of the results of all tests to the
-

- Consultant. Acceptance test will not begin until the tests have been reviewed and accepted. Consultant and Commissioning Authority shall witness these tests.
- .8 Provide the calibration procedure for each analog sensor. Physically check the calibration of each analog sensor type using a calibrated instrument prior to testing.
 - .9 When all tests have been completed BAS Contractor shall request the acceptance test procedure shall begin. Consultant shall verify the installation is complete and all tests have been performed and have been successful. BAS Contractor shall then initiate the acceptance test.
 - .10 The acceptance test period shall be 21 Days. BAS Contractor shall visit the site each morning. Monday to Friday, to review the Building Automation and Controls Systems operation and the building operators log book. The operators log book shall be provided by the BAS Contractor and shall contain all problems experienced by the Custodians. The log shall show the point name and number, time and date of failure and time of return service. During the first 14 Days of the acceptance test, any operational or equipment failures shall be corrected and the acceptance test shall continue from the date the failure has been corrected. During the last 7 Days of testing, no major failures of any kind will be accepted, or the last 7 Days shall be repeated.
 - .11 During the acceptance test Contractor shall print out 1 "all-points" log per day. The logs shall be issued to Consultant for review.
 - .12 BAS Contractor shall set up trend logs and group logs which shall be stored on hard disk for review by Consultant.
 - .13 System shall not be accepted or considered substantially complete until all tests are completed and approved.
 - .14 BAS Contractor shall provide a minimum of 2 weeks notice to Consultant prior to testing date.
 - .15 BAS Contractor shall revisit the site during the first year of operation to review the performance of the Building Automation and Controls Systems. The review shall include DDC loop tuning, sensor calibration, programs, communication, DDC panels, workstations and the operational logs. The visits shall be a minimum of 8 hours each visit. The visits shall be:
 - .1 beginning of cooling season;
 - .2 during the cooling season;
 - .3 beginning of heating season;
 - .4 during the heating season.

3.12 OPERATING AND MAINTENANCE MANUAL

- .1 Contractor shall prepare and submit the Operating and Maintenance Manual as detailed in the specification to Consultant 6 weeks prior to beginning of training.
 - .2 Contractor shall re-submit the manual should the Consultant find deficiencies. Training shall not begin until the manual has been accepted by the Consultant.
 - .3 One copy of the manual shall be forwarded to Commissioning Authority for review and comments.
-

- .4 Operating procedures shall be the recommended manufacturer's operating procedures for the equipment.
- .5 Maintenance procedures shall include Scope of Work, frequency of activity, parts required and necessary documentation.
- .6 Spare parts list shall be manufacturer's recommended list for maintenance purposes.
- .7 Trouble shooting guide shall be manufacturer's recommendation for equipment.
- .8 Equipment list shall include make, model, serial number, electrical characteristics, RPM, pump impeller sizes, fan belt and sheave sizes.
- .9 The Operating and Maintenance Manual will be used by the maintenance personnel to assist them in the daily operation of the systems.

3.13 OPERATOR TRAINING AND INSTRUCTIONS

- .1 Contractor and equipment manufacturers shall provide operator training for each mechanical system and equipment.
- .2 The training and instruction shall be provided by qualified technicians and shall be conducted in a classroom setting at the equipment or system.
- .3 Training and instruction will begin when the Operating and Maintenance Manual has been approved and delivered to Owner.
- .4 Each session shall be structured to cover:
 - .1 the Operating and Maintenance Manual;
 - .2 operating procedures;
 - .3 maintenance procedures;
 - .4 trouble-shooting procedures;
 - .5 manufacturer's or service representative's name, address and phone number.
- .5 Contractor shall prepare a detailed training and instruction plan. This plan shall include the outline of all sessions and identification of the training presenters.
- .6 Submit the plan including a copy of training manual for Commissioning Authority's review and comment.
- .7 Provide course documentation for up to 6 people.
- 1.1.1 Training and instruction shall be provided for the following systems wherever applicable:
 - .1 air handling units;
 - .2 heating and chilled water system;
 - .3 mechanical systems;
 - .4 plumbing and drainage systems
 - .5 building automation and controls
- .8 The minimum training and instruction for the Building Automation and Controls Systems

shall be 10 Days. This training shall be conducted with a minimum of 2 training sessions per topic to cover various plant shifts. BAS training to be conducted at 2pm on day of training to cover plant shift changes. The training shall include:

- .1 a 2 Day class session at manufacturer's local office for 2 of maintenance personnel;
 - .2 a walk-through of the installation for all maintenance personnel to review the installation and equipment;
 - .3 operation of the central computer;
 - .4 operation of portable terminals;
 - .5 control sequences;
 - .6 report set-up and generation;
 - .7 managing the system;
 - .8 maintenance requirements.
- .9 Training and instruction requirement for the mechanical system shall include a walk-through of building by Contractor. During the walk-through the Contractor shall:
- .1 identify equipment;
 - .2 identify starters associated with equipment;
 - .3 identify valves and balancing dampers;
 - .4 identify access doors;
 - .5 review general maintenance of equipment;
 - .6 review drain points in pipework systems;
 - .7 identify maintenance items.
- .10 Contractor shall arrange for video-taping of all training to be provided. Video-taping is to be of high quality and copies shall be provided to the Owner's representative prior to occupancy.

3.14 SYSTEMS DEMONSTRATION AND TURNOVER

- .1 System demonstration and turnover to the Owner shall occur when:
 - .1 the installation is complete;
 - .2 acceptance test conducted by the Consultant has been successfully completed;
 - .3 Commissioning Authority systems testing and verification has been successfully complete;
 - .4 training and instruction has been completed;
 - .5 Operating and Maintenance Manuals have been accepted;
 - .6 shop drawings have been updated;
 - .7 as-built drawings have been completed.

- .2 Systems demonstration shall be conducted by Contractor and manufacturers. The demonstration shall cover all operation and maintenance requirements and a physical demonstration of equipment installation and operation.

3.15 INSTALLATION VERIFICATION CHECKLISTS

- .1 Contractor and manufacturers shall complete installation verification checklists listed in this Section and any other additional checklist not included in this specification, but required for the mechanical systems of this project
- .2 Mechanical installation verification checklists to be completed include but are not limited to the following.
 - .1 air handling unit installation verification sheet;
 - .2 fan coil installation verification sheet;
 - .3 fan installation verification sheet;
 - .4 humidifier installation verification sheet;
 - .5 pump installation verification sheet;
 - .6 unit heaters;
 - .7 hot water heater installation verification sheet;
 - .8 heat pump installation verification sheet;
 - .9 domestic hot water heater installation verification sheet;
 - .10 domestic hot water heater storage tank installation verification sheet;
 - .11 variable air volume box installation verification sheet;
 - .12 convector installation verification sheet;
 - .13 heat exchanger installation verification sheet;
 - .14 water meter installation verification sheet;
 - .15 gas meter installation verification sheet;

3.16 MANUFACTURER'S STARTUP REPORTS

- .1 The following Manufacturer's startup reports to be submitted to the Consultant and Commissioning Authority for review and comment.
- .2 Manufacturer's startup reports required are listed below, but are not limited to the following.
 - .1 air handling units
 - .2 fan coils
 - .3 fans
 - .4 humidifier
 - .5 pumps
 - .6 unit heaters

- .7 hot water tank
- .8 heat pump
- .9 chemical treatment
- .10 water meters
- .11 gas meters

3.17 FUNCTIONAL PERFORMANCE TEST FORMS

- .1 The following functional performance test forms will be completed by Commissioning Authority for the following equipment.
 - .1 air handling units
 - .2 fan coils
 - .3 fans
 - .4 humidifier
 - .5 pumps
 - .6 unit heaters
 - .7 hot water tank
 - .8 hot water heating system
 - .9 chilled water system including heat pump
 - .10 heating water water system including heat pump and heat exchangers
 - .11 domestic hot water heating system
 - .12 terminal units including VAV boxes and perimeter convectors
 - .13 building automation system

3.18 EQUIPMENT AND SYSTEM WARRANTIES

- .1 Equipment and system warranties shall be as defined in Division 1.
- .2 Contractor shall fill-out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to Division 1 and all Mechanical and Electrical divisions of the specification for the requirements during the warranty period.
- .4 Contractor shall re-visit the building during the warranty period with Consultant, Commissioning Authority and Owner. During these visits the performance of the system shall be reviewed. These visits shall occur:
 - .1 once during the first month of building operation;
 - .2 once during the third month of building operation;
 - .3 once between fourth and tenth month in a session opposite to the first and third month visits.

- .5 The Owner shall organize these visits.
- .6 At these meetings Owner, Consultants, and Commissioning Authority shall review the performance of the systems. If the performance is satisfactory then no further action required. If unsatisfactory then Contractor will be instructed to correct deficiencies, at his cost, to the satisfaction of Consultant.
- .7 The contractor shall re-visit the building as required to perform deferred functional performance testing with the Commissioning Authority for equipment that must be verified in the opposite season.

3.19 CONSTRUCTION COMMISSIONING REPORT

- .1 Provide a Commissioning Report documenting all the commissioning work, testing and results accomplished during the construction period. Commissioning Report to include the following:
 - .1 Identification of any systems or assemblies that do not perform in accordance with
 - .1 Specifications.
 - .2 Test procedures and results.
 - .3 Deferred tests (seasonal) with proposed schedule.
 - .4 Start-up check lists for all equipment, systems, and assemblies.
 - .5 Factory test results with comments.
 - .6 All commissioning site inspection reports.
 - .7 All commissioning progress reports.
 - .8 Construction phased training records.
 - .9 The final version of the Commissioning Plan.

3.20 FINAL COMMISSIONING REPORT

- .1 Provide final Commissioning Report for inclusion with project as-built documents at the end of the warranty period. This Commissioning Report must include all necessary documentation to permit a future re-commissioning of the entire facility and a return to all original 'as-commissioned' operating parameters. Final report to include all final training sessions, post occupancy changes to the Commissioning Plan, results from any deferred or seasonal commissioning and other information not available or incomplete at the end of construction and include the following:
 - .1 Executive summary of findings and recommendations.
 - .2 A detailed description of findings and recommendations.
 - .3 Lessons-learned as discussed in the Lessons-learned workshop. The workshop is to be facilitated by the Design Team.
 - .4 Test procedures and results.
 - .5 Identify any systems or assemblies that do not perform per specifications and factors related to non-compliance.
 - .6 Deferred Test results.
 - .7 Start-up checklists for all equipment, systems, and assemblies.
 - .8 Factory test reports with comments.
 - .9 All commissioning site inspection review reports.
 - .10 Training records.
 - .11 All testing and commissioning Documents to satisfy the CaGBC commissioning requirements
 - .12 The final version of the Commissioning Plan.
- .2 Provide draft version of Commissioning report to Project Team and Owner for review and comment. Provide two (2) hard copies and one (1) softcopy of the final Commissioning Report incorporating any review comments.

END OF SECTION

Part 1 General

1.1 GENERAL INSTRUCTIONS

- .1 Read and conform to:
 - .1 Section 01 91 13 - Facility Commissioning – General
 - .2 Section 01 91 14 - Facility Commissioning – Mechanical
 - .3 Comply with Division 1 Requirements and Documents referred to herein.

1.2 SYSTEMS TO BE COMMISSIONED

- .1 Refer to Section 01 91 13.13 Commissioning Plan

1.3 DOCUMENTATION

- .1 Contractor shall record test results and procedures on approved record forms and submit the forms together with copies of test certificates to Consultant and Commissioning Authority for review and approval.
- .2 When results are validated, Commissioning Authority shall incorporate those records in his System Description Manual. These test results will be entered into the appropriate sections of the System Operating and Maintenance Manual as reference for future system/equipment performance tests.

1.4 RESPONSIBILITIES

- .1 Commissioning Authority: to perform and complete all work as specified in the “GENERAL” Section of this specification “Responsibilities of Commissioning Authority”.
 - .2 Contractors: To perform and complete all works as specified in the “GENERAL” Section of this specification “Responsibilities of Contractor”. In general, it shall include complete activation of all systems; calibration, test, and verification of performance of all components, equipment and systems; verification of performance of all systems through all specified modes of control and sequence of operation along with simulated reasonable operational situations; rectification of deficiencies; recording of test results for submission; demonstration, instruction and training of Owner’s operating and maintenance personnel; follow-up during first year of operation for fine tuning and building service monitoring.
 - .3 Equipment verification: Contractor shall test and verify proper operation of all equipment and systems prior to start of commissioning and record all results from the test for each piece of equipment. Forms shall be included in the Operating and Maintenance Manual. Equipment data shall include, but is not limited to:
 - .1 manufacturer’s name, address and telephone number;
 - .2 distributors’ name, address and telephone number;
 - .3 make, model number and serial number;
 - .4 electrical – volts, amps, fuse size, overload size;
 - .5 equipment enclosure type;
-

Part 2 Testing Equipment

2.1 GENERAL

- .1 Contractor and manufacturer shall provide all instrumentation and test equipment necessary to conduct the tests specified during the commissioning process. Contractor shall submit a list of equipment to be used and copies of latest equipment calibration certificates to the Commissioning Authority and Consultant for review and comment.

Part 3 Testing for Electrical Systems

3.1 GENERAL

- .1 Carry out all pre-service checks, inspection and testing as recommended by the equipment manufacturers
- .2 Carry out all checks, testing and inspections as required by the electrical (Div.26, 27 & 28) specifications.

3.2 LIGHTING & LIGHTING CONTROL SYSTEMS

- .1 Check all light fittings are installed correctly and switched as designed
- .2 Check operation of all emergency light fittings
- .3 Check that light levels meet the requirements of the Basis of Design .
- .4 Submit a lighting control sequence of operation (SOO) to the consultant and CxA for review prior to commissioning the lighting control system. During commissioning verify the complete lighting control system is operating according to this SOO.
- .5 After commissioning the daylight linking functionality of the lighting control system, be prepared to return to site to tune that system in seasonal lighting conditions generally as required by clause 3.9.4 below. This should include for the full range of daylighting experienced throughout the day especially including low sun angles.

3.3 ELECTRICAL DISTRIBUTION SYSTEM

- .1 Check and inspect the panels and busduct tap-offs to ensure they are installed in accordance with the manufacturers recommendations, code requirements and the specifications. Verify name plate data.
 - .2 Check the installation is complete and ready and safe to carry out the testing; ensure grounding is complete and environment appropriate for level of protection
 - .3 Verify panelboard directory is present and correct
 - .4 Inspect cable terminations for correct installation method
 - .5 Check all protective devices are set as per the approved coordination study
 - .6 Megger test where required
 - .7 After the equipment is energized, check and test phase sequence, voltages and load on the system and on each feeder.
-

3.4 TRANSFORMERS

- .1 Independent third party or manufacturer shall carry out the following tests:
 - .1 check and record nameplate data.
 - .2 check and report the transformer enclosure is suitable for the environment in which it is installed.
 - .3 check and record sizes and types of primary and secondary protection devices, conductor sizes and types.
 - .4 check cables are properly installed, terminated and tightened to the correct torque values.
 - .5 megger the primary and secondary windings.
 - .6 measure the primary and secondary winding resistances.
 - .7 grounding test to ensure transformer is properly grounded.
 - .8 polarity and phase sequence tests.
 - .9 sound level test for different points at 1 m (3') away from transformers.
 - .10 check and record transformer primary and secondary voltages and load current. Check and record transformer on-load temperatures.

3.5 OPERATING AND MAINTENANCE MANUAL

- .1 Contractor shall prepare and submit the Operating and Maintenance Manual as detailed in the specification to the Consultant 6 weeks prior to beginning of training.
- .2 Contractor shall re-submit the manual should the Consultant find deficiencies. Training shall not begin until the manual has been accepted by the Consultant.
- .3 One copy of the manual shall be forwarded to Commissioning Authority for review and comment.
- .4 Operating procedures shall be the recommended manufacturer's operating procedures for the equipment.
- .5 Maintenance procedures shall include Scope of Work, frequency of activity, parts required and necessary documentation.
- .6 Spare parts list shall be manufacturer's recommended list for maintenance purposes.
- .7 Trouble shooting guide shall be manufacturer's recommendation for equipment.
- .8 Equipment list shall include make, model, serial number, electrical characteristics, lighting performance etc
- .9 The Operating and Maintenance Manual will be used by the maintenance personnel to assist them in the daily operation of the systems.

3.6 TRAINING

- .1 Develop a training plan and schedule in consultation with Project Team. The training plan should incorporate a complete system and assembly review of operational procedures,
-

set points and maintenance requirements. Commissioning Consultant shall provide the following:

- .1 Coordinate training sessions between the Owner's O&M personnel.
 - .2 Ensure Draft 'Operating and Maintenance Manuals (OMM) are provided for training (if complete manuals are unavailable).
 - .3 Verify that training is provided by the appropriate equipment manufacturer's representative.
 - .4 Provide 'Manufacturers Training' of equipment and/or components pre-recorded video tapes or site-produced tapes describing the equipment and its components, including normal operations, safety features, maintenance schedules and control and monitoring functions, if available.
 - .5 Ensure provisions of tours of the facilities at appropriate junctions with verbal and visual descriptions provided.
 - .6 Provide classroom training sessions, if required. The University will provide training facilities and coordinate with the University Project Officer.
 - .7 The training and instruction shall be provided by qualified technicians and shall be conducted in a classroom setting at the equipment or system.
 - .8 Training and instruction will begin when the Operating and Maintenance Manual has been approved and delivered to Owner.
 - .9 Each session shall be structured to cover:
 - .1 the Operating and Maintenance Manual;
 - .2 operating procedures;
 - .3 maintenance procedures;
 - .4 trouble-shooting procedures;
 - .5 manufacturer's or service representative's name, address and phone number.
 - .10 Provide course documentation for up to 6 people.
- .2 Training and instruction shall be provided for the following systems wherever applicable:
- .1 Electrical Distribution
 - .2 Luminaires and lighting control system
 - .3 Fire Alarm System
 - .4 Training and instruction requirement for the electrical distribution system shall include a walk-through of building by Contractor.
 - .5 Each training session is to be videotaped by the Commissioning Agent, and electronic copies are provided to the Owner's O&M personnel. Commissioning Agent to provide all video equipment for the taping of training sessions.
 - .6 Verify the training requirements have been met.
-

3.7 SYSTEMS DEMONSTRATION AND TURNOVER

- .1 System demonstration and turnover to the Owner shall occur when:
 - .1 the installation is complete;
 - .2 acceptance test conducted by the Consultant has been successfully completed;
 - .3 Commissioning Authority systems testing and verification has been successfully complete;
 - .4 training and instruction has been completed;
 - .5 Operating and Maintenance Manuals have been accepted;
 - .6 shop drawings have been updated;
 - .7 as-built drawings have been completed.
- .2 Systems demonstration shall be conducted by Contractor and manufacturers. The demonstration shall cover all operation and maintenance requirements and a physical demonstration of equipment installation and operation.

3.8 INSTALLATION VERIFICATION CHECKLISTS

- .1 Contractor and manufacturers shall complete installation verification checklists listed in this Section and any other additional checklist not included in this specification, but required for the electrical systems of this project.
- .2 Electrical installation verification checklists to be completed include but are not limited to the following.
 - .1 Electrical switchgear installation verification sheet;
 - .2 Lighting installation verification sheet;
 - .3 Electrical metering installation verification sheet;
 - .4 Transformer electrical installation verification sheet;
 - .5 Electrical distribution panel installation verification sheet;

3.9 MANUFACTURER'S STARTUP REPORTS

- .1 The following Manufacturer's startup reports to be submitted to the Consultant and Commissioning Authority for review and comment.
- .2 Manufacturer's startup reports required are listed below, but are not limited to the following.
 - .1 Lighting system
 - .2 Switchgear equipment
 - .3 Metering systems.

3.10 FUNCTIONAL PERFORMANCE TEST FORMS

- .1 The following functional performance test forms will be completed by Commissioning Authority for the following equipment.
-

- .1 Lighting Control System
- .2 Metering System

3.11 CONSTRUCTION COMMISSIONING REPORT

- .1 Provide a Commissioning Report documenting all the commissioning work, testing and results accomplished during the construction period. Commissioning Report to include the following:
 - .1 Identification of any systems or assemblies that do not perform in accordance with
 - .1 Specifications.
 - .2 Test procedures and results.
 - .3 Deferred tests (seasonal) with proposed schedule.
 - .4 Start-up check lists for all equipment, systems, and assemblies.
 - .5 Factory test results with comments.
 - .6 All commissioning site inspection reports.
 - .7 All commissioning progress reports.
 - .8 Construction phased training records.
 - .9 The final version of the Commissioning Plan.

3.12 EQUIPMENT AND SYSTEM WARRANTIES

- .1 Equipment and system warranties shall be as defined in Division 1.
 - .2 Contractor shall fill-out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
 - .3 Refer to Division 1 and all Mechanical and Electrical divisions of the specification for the requirements during the warranty period.
 - .4 Contractor shall re-visit the building during the warranty period with Consultant, Commissioning Authority and Owner. During these visits the performance of the system shall be reviewed. These visits shall occur:
 - .1 once during the first month of building operation;
 - .2 once during the third month of building operation;
 - .3 once between fourth and tenth month in a session opposite to the first and third month visits.
 - .5 The Owner shall organize these visits.
 - .6 At these meetings Owner, Consultants, and Commissioning Authority shall review the performance of the systems. If the performance is satisfactory then no further action required. If unsatisfactory then Contractor will be instructed to correct deficiencies, at his cost, to the satisfaction of Consultant.
-

3.13 FINAL COMMISSIONING REPORT

- .1 Provide final Commissioning Report for inclusion with project as-built documents at the end of the warranty period. This Commissioning Report must include all necessary documentation to permit a future re-commissioning of the entire facility and a return to all original 'as-commissioned' operating parameters. Final report to include all final training sessions, post occupancy changes to the Commissioning Plan, results from any deferred or seasonal commissioning and other information not available or incomplete at the end of construction and include the following:
 - .1 Executive summary of findings and recommendations.
 - .2 A detailed description of findings and recommendations.
 - .3 Lessons-learned as discussed in the Lessons-learned workshop. The workshop is to be facilitated by the Design Team.
 - .4 Test procedures and results.
 - .5 Identify any systems or assemblies that do not perform per specifications and factors related to non-compliance.
 - .6 Deferred Test results.
 - .7 Start-up checklists for all equipment, systems, and assemblies.
 - .8 Factory test reports with comments.
 - .9 All commissioning site inspection review reports.
 - .10 Training records.
 - .11 All testing and commissioning Documents to satisfy the CaGBC commissioning requirements
 - .12 The final version of the Commissioning Plan.
- .2 Provide draft version of Commissioning report to Project Team and Owner for review and comment. Provide two (2) hard copies and one (1) softcopy of the final Commissioning Report incorporating any review comments.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes descriptions for demolishing, salvaging, recycling and removing site work items identified for removal in whole or in part, and for backfilling trenches and excavations resulting from site demolition activities.

1.2 DEFINITIONS

- .1 Selective Demolition: Sequencing demolition activities to allow separation and sorting of selected site materials.
- .2 Hazardous Substances: dangerous substances, dangerous goods, hazardous commodities and hazardous products, including but not limited to: asbestos PCB's, CFC's, HCFC's poisons, corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or other material that can endanger human health or well being or environment if handled improperly.

1.3 REFERENCE STANDARDS

- .1 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 2012
 - .2 Canadian Environmental Protection Act (CEPA), 2012
 - .1 SOR/2003-2, On-Road Vehicle and Engine Emission Regulations
 - .2 SOR/2006-268, Regulations Amending the On-Road Vehicle and Engine Emission Regulations
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34
 - .4 Motor Vehicle Safety Act (MVSA), 1995
 - .5 Hazardous Materials Information Review Act, 1985
- .2 Underwriters' Laboratories of Canada (ULC)
 - .1 [CAN/ULC-S660-08](#), Standard for Nonmetallic Underground Piping for Flammable and Combustible Liquids
 - .2 ULC/ORD-C58.15-1992, Overfill Protection Devices for Flammable Liquid Storage Tanks
 - .3 ULC/ORD-C58.19-1992, Spill Containment Devices for Underground Flammable Liquid Storage Tanks

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate with Owner for the material ownership including the following:
 - .1 Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.
 - .2 Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during demolition remain Owner's property:
 - .1 Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.

- .2 Coordinate with Owner's historical adviser, who will establish special procedures for removal and salvage operations.
- .2 Scheduling:
 - .1 Employ necessary means to meet project time lines without compromising specified minimum rates of material diversion.
 - .2 In event of unforeseen delay notify Consultant as outlined in the contract.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
 - .1 Schedule of Selective Site Demolition Activities in Construction Progress Schedule - Critical Path Method (CPM), and indicate the following:
 - .1 Detailed sequence of selective site demolition and removal work, with starting and ending dates for each activity
 - .2 Interruption of utility services
 - .3 Coordination for shutoff, capping, and continuation of utility services
 - .4 Locations of temporary partitions and means of egress
 - .2 Inventory: Submit a list of items that have been removed and salvaged after selective site demolition is complete
 - .1 Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
- .2 Informational Submittals: Provide the following submittals when requested by the Consultant:

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: ensure Work is performed in compliance with applicable Provincial/Territorial regulations.
- .2 Comply with hauling and disposal regulations of Authority Having Jurisdiction.

1.7 SITE CONDITIONS

- .1 Environmental protection:
 - .1 Ensure Work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.
 - .2 Fires and burning of waste or materials is not permitted on site.
 - .3 Burying of rubbish waste materials is not permitted.
 - .4 Disposal of waste of volatile materials including but not limited to, mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers, is not permitted.
 - .5 Ensure proper disposal procedures are maintained throughout the project.
- .2 Pumping of water containing suspended materials into watercourses, storm or sanitary sewers or onto adjacent properties, is not permitted.
- .3 Control disposal or runoff of water containing suspended materials or other harmful substances as directed by the consultant and as outlined in the contract documents.

- .4 Protect trees, plants and foliage on site and adjacent properties where indicated.
- .5 Prevent extraneous materials from contaminating air beyond application area, by providing temporary enclosures during demolition work.
- .6 Cover or wet down dry materials and waste to prevent blowing dust and debris. Control dust on all temporary roads.
- .7 Conduct selective site demolition so Owner's operations will not be disrupted:
 - .1 Provide not less than 72 hours' notice to Consultant of activities that will affect operations.
 - .2 Maintain access to existing walkways, exits, and other adjacent occupied or used facilities:
 - .1 Closing or obstructing walkways, exits, or other occupied or used facilities without written permission from Consultant is not permitted.
- .8 Consultant assumes no responsibility for Selective Site elements being demolished:
 - .1 Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - .2 Before selective site demolition, remove, protect and store salvaged items as directed by Consultant:
 - .1 Salvage items as identified by Consultant.
 - .2 Deliver to Owner as directed.

1.8 EXISTING CONDITIONS

- .1 Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work:
 - .1 Hazardous materials will be as defined in the Hazardous Materials Act.
 - .2 Hazardous materials will be removed by Owner before start of the Work.
- .2 If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Consultant. Hazardous materials will be removed by Owner under a separate contract or as a change to the Work.
- .3 If material resembling spray or trowel applied asbestos or other designated substance listed as hazardous be encountered in course of demolition, stop work, take preventative measures, and notify Consultant immediately. Proceed only after receipt of written instructions have been received from Consultant.
- .4 Site elements that will be demolished are based on their condition on date that tender is accepted.

Part 2 Products

2.1 EQUIPMENT

- .1 Equipment and Heavy Machinery:
 - .1 On-road vehicles to: CEPA-SOR/2006-268 , Regulations Amending the On-Road Vehicle and Engine Emission Regulations.
 - .2 Off-road vehicles to: EPA CFR 86.098-10 and EPA CFR 86.098-11.
 - .3 Machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

Part 3 Execution

3.1 EXAMINATION

- .1 Survey existing conditions and correlate with requirements indicated to determine extent of selective site demolition required.
- .2 Consultant does not guaranty that existing conditions are the same as those indicated in Project Record Documents.
- .3 Inventory and record the condition of items being removed and salvaged.
- .4 When unanticipated mechanical, electrical, or structural elements are encountered, investigate and measure the nature and extent of the element. Promptly submit a written report to Consultant.
- .5 Engage a professional engineer to perform an engineering survey of condition of adjacent buildings to determine whether removing any site element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective site demolition operations.
- .6 Verify that hazardous materials have been remediated before proceeding with site demolition operations.

3.2 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to: requirements of authorities having jurisdiction.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during demolition.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal after completion of demolition work.
- .2 Protection of in-place conditions:
 - .1 Prevent movement, settlement or damage of adjacent structures, services, walks, paving, trees, landscaping, adjacent grades and properties.
 - .1 Provide bracing, shoring and underpinning as required.
 - .2 Repair damage caused by demolition as directed by Consultant.
 - .2 Support affected site elements and, if safety of site element being demolished or adjacent structures or services appears to be endangered, take preventative measures, stop Work and immediately notify Consultant.
 - .3 Prevent debris from blocking surface drainage system, elevators, mechanical and electrical systems which must remain in operation.
- .3 Surface Preparation:
 - .1 Disconnect and re-route electrical and service lines within the site to be demolished.
 - .1 Post warning signs on electrical lines and equipment which must remain energized to serve other properties during period of selective site demolition.

- .2 Disconnect and cap designated mechanical services.
 - .1 Natural gas supply lines: remove in accordance with gas company requirements.
 - .2 Sewer and water lines: remove as directed by Consultant.
- .3 Disruption of active or energized utilities designated to remain undisturbed is not permitted.

3.3 REMOVAL AND DEMOLITION OPERATIONS

- .1 Remove items as indicated.
- .2 Disruption of items designated to remain in place is not permitted.
- .3 Removal of pavements, curbs and gutters:
 - .1 Square up adjacent surfaces to remain in place by saw cutting or other method approved by Consultant.
 - .2 Protect adjacent joints and load transfer devices.
 - .3 Protect underlying and adjacent granular materials.
- .4 Excavate at least 300 mm below pipe invert, when removing pipes under existing or future pavement area.
- .5 Decommission water wells and monitoring wells in accordance with Territorial regulations.
- .6 Removedesignated trees during demolition.
 - .1 Obtain written approval of Consultant prior to removal of trees not designated.
- .7 Disposed of alternately trees designated for removal and identified by Consultant to be healthy.
 - .1 Grind, chip, or shred other vegetation for mulching and composting, or use as mill pulp.
- .8 Stockpile topsoil for final grading and landscaping:
 - .1 Provide erosion control and seeding if not immediately used.
- .9 Disposal of Material:
 - .1 Dispose of materials not designated for salvage or reuse on site as instructed by Consultant.
 - .2 Trim disposal areas to approval of Consultant.
- .10 Backfill: Backfill in areas as indicated and in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.4 STOCKPILING

- .1 Label stockpiles, indicating material type and quantity.
- .2 Designate appropriate security resources/measures to prevent vandalism, damage and theft.
- .3 Locate stockpiled materials convenient for use in new construction to eliminate double handling wherever possible.

- .4 Stockpile materials designated for alternate disposal in location which facilitates removal from site and examination by potential end markets, and which does not impede disassembly, processing, or hauling procedures.

3.5 REMOVAL FROM SITE

- .1 Remove stockpiled material as directed by Consultant, when it interferes with operations of project.
- .2 Remove stockpiles of like materials by alternate disposal option once collection of materials is complete.
- .3 Transport material designated for alternate disposal using approved facilities listed in CWM Plan and in accordance with applicable regulations:
 - .1 Written authorization from Consultant is required to deviate from facilities listed in CWM Plan.
- .4 Dispose of materials not designated for alternate disposal in accordance with applicable regulations.

3.6 RESTORATION

- .1 Restore areas and existing works outside areas of demolition to conditions that existed prior to beginning of Work.
- .2 Use soil treatments and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.

3.7 CLEANING

- .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

1. General

1.1 SCOPE OF WORK

- .1 The Scope of Work shall include: All testing of concrete and grout.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 Concrete Reinforcing Section 03 20 00
.2 Cast-in-Place Concrete Section 03 30 00

1.3 REFERENCE STANDARDS

- .1 Perform all work in accordance with the following standards, except where specified otherwise. All standards to be latest issue at the time of tender.
.2 Canadian Standards Association:
.1 CSA-A23.1-19 Concrete Materials and Methods of Concrete Construction.
.2 CSA-A23.2-19 Methods of Test for Concrete.
.3 CSA-A23.3-19 Design of Concrete Structures.
.4 CSA-A283-19 Qualification Code for Concrete Testing Laboratories.

1.4 REGULATIONS

- .1 Abide by the current bylaws and regulations of the territory and/or municipality in which the work is located and abide by the current laws and regulations with regard to crossing and public safety.
.2 The regulations of the Minister of Labour, Occupational Health and Safety Act, the Workers' Compensation Board and other applicable acts administered by the authority having jurisdiction of the territory apply to the work of this section.

1.5 SAFETY

- .1 Carry out work in accordance with the current Occupational Health and Safety Act and construction safety regulations.

1.6 APPOINTMENT OF TESTING AGENCY

- .1 The Owner may hire a CSA-approved Testing Agency who shall test concrete, reinforcement, and grout as per this specification.
.2 Testing paid for by the Owner:
.1 Review of initial mix designs.
.2 Testing as outlined in Section 3.0, except for testing required by the Contractor for stripping of formwork.
.3 Testing paid for by the Contractor:
.1 Review of Contractor requested mix design changes.
.2 Any waiting time incurred by the Testing Agency in excess of 1/2 an hour.
.3 Any additional costs due to overtime, shift work, holiday or weekend work, except that the Owner will pay for holiday or weekend pickup when the concrete was placed on a regular workday.
.4 Costs for testing required by the Contractor for stripping of formwork, such as field cure cylinders etc.
.5 Cost for retesting or additional testing of concrete or reinforcement where tests have failed to meet the specified requirements.

1.7 SUBMITTALS

- .1 Submittals in accordance with Section 01 00 10 – General Requirements.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 The Contractor is to provide properly designed temperature-controlled storage boxes for test cylinders, as specified in CSA-A23.2, for a period of at least 24 hours and further protection from adverse weather and mishandling until removed from the site. The Contractor is to provide a max-min thermometer for each storage box. Storage in a portable building that will be used by the Contractor's personnel or the Consultant during the first 24 hour storage period will not be permitted. Storage facilities are to be provided, installed, checked and approved before any concrete may be placed.

2. Inspection and Testing of Concrete and Grout

2.1 RESPONSIBILITY OF THE CONTRACTOR

- .1 The Contractor shall cooperate fully with the Testing Agency.
- .2 The Contractor shall give the Testing Agency at least 24 hours prior notice of a concrete placement.
- .3 Contractor shall provide a finished product that meets the specification. If initial tests indicate that the concrete failed to meet the specification, additional testing is necessary. This testing shall be done by a CSA-approved Testing Agency but need not be the Owner's agency.
- .4 Core strengths must equal the specified strength if tested dry or 85% of specified if tested wet, with wet or dry tests as per the Standard.
- .5 Provide casual labour to the testing firm's field personnel for the purpose of obtaining, handling, and storing sample materials. Provide free access to all portions of the work, and cooperate with the testing firm.
- .6 The Contractor is to provide properly designed temperature-controlled storage boxes for test cylinders, as specified in CSA-A23.2, for a period of at least 24 hours and further protection from adverse weather and mishandling until removed from the site. The Contractor is to provide a max-min thermometer for each storage box. Storage in a portable building that will be used by the Contractor's personnel or the Consultant during the first 24 hour storage period will not be permitted. Storage facilities are to be provided, installed, checked and approved before any concrete may be placed
- .7 Field cure cylinders shall be stored on the floor right below the slab they represent and be protected against wind unless the floor below is heated, in which case they shall be stored on top of the slab but covered with a plywood box. The cylinders are to be undisturbed at this location until picked up by the Testing Agency.

2.2 RESPONSIBILITY AND DUTIES OF THE TESTING AGENCY

- .1 The Testing Agency is responsible to the Owner and has the authority to and is expected to reject any concrete not meeting the specifications.
- .2 If the Testing Agency becomes aware that concrete is being placed without their notification, or if insufficient notice is received, then the Testing Agency shall notify the Owner immediately.
- .3 Low 7-day, 28-day and 56-day strength tests shall be brought immediately to the attention of the Consultant.
- .4 Test all concrete by a testing firm certified in accordance with CSA-A283, approved by the Consultant.
- .5 Testing firm is not authorized to revoke, relax, enlarge or release any requirements of the specification, nor to approve or disapprove any portion of the work.

- .6 Testing firm to submit to the Consultant a final report certifying that all concrete and grout is in accordance with the contract documents. Submit the report under the seal and signature of a professional engineer registered in the Yukon.

2.3 CONCRETE TESTING - GENERAL

- .1 All strength tests shall be numbered consecutively and the cylinders marked as follows:
 - .1 7-Day Test: Marked "A".
 - .2 28-Day Test: Two (2) cylinders marked "B" and "C".
 - .3 56-Day Test: Where these are required by the drawings and specifications, two (2) cylinders marked "D" and "E".
- .2 Test reports shall record:
 - .1 Name of Project
 - .2 Date and time of sampling
 - .3 Name of supplier
 - .4 Delivery truck number
 - .5 Batch time and discharge time
 - .6 Identification of sampling and testing technicians
 - .7 Exact location in the structure of the concrete sampled
 - .8 Mix design, design strength slump and air content of concrete sampled
 - .9 Admixtures, cement type, maximum aggregate size
 - .10 Air and concrete temperature
 - .11 Slump, and air content
 - .12 Nominal aggregate size
 - .13 Water added and personnel authorizing additional water
- .3 Field cured cylinders shall be marked "F".
- .4 Slump tests shall be performed prior to the addition of super-plasticizers.
- .5 Tests for slump and air content shall be taken with each strength test and as required by the specifications and drawings.
- .6 Analysis of Concrete Production
 - .1 A summary table and associated strip charts shall be submitted to the Consultant for all classes of structural concrete placed on projects with 25 or more compressive strength tests.
 - .2 Summary tables are to indicate at least the following information:
 - .1 Classification of Concrete.
 - .2 Project name.
 - .3 Test number.
 - .4 Compressive strength of concrete.
 - .5 Supplier's ticket number.
 - .6 Date concrete placed.
 - .7 Time batched.

- .8 Time tested.
- .9 Slump.
- .10 Air entrainment.
- .11 1-7 day and 2–28 day compressive strength test results for each test.
- .12 Average strength and within test variation for the two (2) 28-day concrete test results for each test
- .13 Moving average of 3 consecutive 28 day concrete test results.
- .14 Average and standard deviation of 28 day concrete test results and an evaluation of conformance to CSA production guidelines.
- .3 Charts shall plot concrete slump, air content, individual compressive strength tests, and the moving average of 3 consecutive compressive strength tests.
- .4 Tables and charts for each type or class of concrete are to be provided on a monthly basis for concrete supplied for the structure until completion of the concrete work.
- .5 When 56-day concrete testing is permitted by the Owner, summary charts and tables shall be provided for concrete tested at 56 days.
- .7 Testing firm is to take one additional test cylinder during cold weather concreting and cure on job site under same conditions as the concrete it represents.
- .8 Testing firm is to take at least one slump test and one entrained air test for each set of test cylinders taken.
- .9 Chloride ion tests shall be performed on the first set of compressive test cylinders taken from the first pour, to show that the chloride ion content of these mixes satisfies the limits set out in CAN/CSA A23.1.
- .10 Testing firm is to report results of tests immediately to the Contractor. The Contractor is responsible for ensuring that the concrete meets the requirements of the specifications. Report adverse test results to the Consultant immediately.
- .11 Reject and do not place concrete with slumps greater than maximum specified, air content lower than minimum specified and concrete over 2 hours from batch time.
- .12 Testing firm is to advise placing crews to halt placing of adverse concrete immediately, and thereafter notify Contractor to reject the concrete. The execution or lack of execution, of this request is to be recorded.
- .13 Conform to the standard, except each test shall consist of three (3) cylinders - one (1) for 7-day strength and two (2) for 28-day strength and 2 for 56-day strength where 56 day concrete is permitted by the Owner.
- .14 Regular testing applied to all elements not listed in Clause 3.3 - Full Time Testing.
- .15 Samples of concrete to be taken as close to the point of final deposit in the form as possible, at end of pipe when pumping is used
- .16 Testing firm to moist cure and test one (1) cylinder in 7 days and to moist cure and test the remaining two (2) cylinders in 28 days or (1) in 7 days, (1) in 28 days and (2) in 56 days

2.4 GROUT – TESTING

- .1 Test all grout by a testing firm certified in accordance with CSA-A283, retained and paid for by the Contractor and approved by the Consultant.
- .2 In accordance with ASTM C109, provide at least two (2) cube tests on all types of non-shrink grout used. Provide at least 5 tests of cement grout but maximum one (1) test per day

End of Section

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 20 00 - Concrete Reinforcing
- .2 Section 03 30 00 - Cast-in-Place Concrete
- .3 Section 07 92 00 - Joint Sealants
- .4 Section 03 35 00 - Concrete Finishing

1.2 ABBREVIATIONS AND ACRONYMS

- .1 HDO: High density overlay plywood
- .2 MDO: Medium density overlay plywood

1.3 DEFINITIONS

- .1 Environmental Product Declaration (EPD): Third-party verified documentation with the supporting Product Category Rule (PCR) and Life cycle Assessment information. Prepared in accordance with ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle-to-gate scope.
 - .1 Industry-wide (generic) EPD with third-party certification (Type III), including external verification in which the manufacturer is explicitly recognized as the participant by the program operator.
 - .2 Product-specific Type III EPD - Products with third-party certification (Type III), including external verification in which the manufacturer is explicitly recognized as the participant by the program operator.

1.4 REFERENCE STANDARDS

- .1 British Standards Institution (BSI Group):
 - .1 EN 15804:2012, Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- .2 CSA Group (CSA):
 - .1 CSA A23.1:19/A23.2:19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
 - .2 CSA O86:19, Engineering Design in Wood
 - .3 CSA O121-17, Douglas Fir Plywood
 - .4 CSA O151-17, Canadian Softwood Plywood
 - .5 CSA O153-13, Poplar Plywood
 - .6 CSA O325-16, Construction Sheathing
 - .7 CSA O437.0-93, OSB and Waferboard
 - .8 CSA S269.1-16, Falsework and Formwork
- .3 International Organization for Standardization (ISO):
 - .1 ISO 14025:2006, Environmental labels and declarations - Type III environmental declarations - Principles and procedures
 - .2 ISO 14040:2006, Environmental management - Life cycle assessment - Principles and framework
 - .3 ISO 14044:2006, Environmental management - Life cycle assessment - Requirements and guidelines
 - .4 ISO 21930:2017, Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services
- .4 ULC Standards (ULC):
 - .1 CAN/ULC-S701.1-17, Standard for Thermal Insulation, Polystyrene Boards

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordinate with Section 03 20 00 - Concrete Reinforcing.
 - .2 Coordinate with Section 03 30 00 - Cast-in-Place Concrete.
 - .3 Coordinate with Section 07 92 00 - Joint Sealants.

- .2 Pre-Installation Meetings: Hold pre-installation meeting one week before beginning concrete works in accordance with Section 01 00 10 – General Requirements.
 - .1 Ensure attendance by Contractor, affected Subcontractors
 - .1 Verify Project requirements.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 – General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, product literature, and data sheets for proprietary materials used in formwork liners and coatings. Include product characteristics, performance criteria, physical sizes, finishes, and limitations.
 - .2 Submit WHMIS Safety Data Sheet (SDS).
- .3 Submit shop drawings for formwork and falsework.
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in the Yukon Territory, Canada.
 - .2 Prepare Shop Drawings in accordance with CSA S269.1 for formwork and falsework.
 - .3 Indicate formwork design data, permissible rate of concrete placement, and temperature of concrete in formwork.
 - .4 Indicate sequence of erection and removal of formwork and falsework.
 - .5 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts.
 - .6 Indicate sequence of erection and removal of formwork and falsework.

1.7 QUALITY ASSURANCE

- .1 Perform in accordance with Section 01 00 10 – General Requirements.
- .2 Retain a professional engineer registered or licensed in the Yukon, with experience in formwork and falsework design of comparable complexity and scope, to perform the following services as part of work of this Section:
 - .1 Design of formwork and falsework.
 - .2 Review, stamp, and sign fabrication and erection Shop Drawings, design calculations and amendments.
 - .3 Conduct on-site inspections and prepare and submit inspection reports verifying this part of work is in accordance with Contract Documents and reviewed Shop Drawings.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Perform in accordance with Section 01 00 10 – General Requirements.
 - .1 Storage and Handling Requirements: Maintain formwork liners for architectural concrete without defects or damages that could affect concrete appearance or cause staining.

Part 2 Products

2.1 MATERIALS

- .1 Formwork materials:
 - .1 For concrete without special architectural features, use wood and wood product formwork materials to CSA O151.
 - .2 For concrete with special architectural features, use formwork materials to CSA A23.1/A23.2.
 - .3 Rigid insulation board: to CAN/ULC-S701.1, Type 2
- .2 Form ties:
 - .1 For concrete not designated 'Architectural': Removable or snap-off metal ties, fixed or adjustable length, and free of devices leaving holes larger than 25 mm in diameter in concrete surface.

- .2 For Architectural concrete: Snap ties complete with plastic cones and provide light grey precast concrete plugs.
- .3 Form release agent: Proprietary, non-volatile material that will not stain concrete or hinder the application of subsequent coatings, treatments, or flooring materials to the concrete surface.
- .4 Sealant: To Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 PREPARATION

- .1 Before placing concrete clean formwork in accordance with CSA A23.1/A23.2.

3.2 FABRICATION AND ERECTION

- .1 Verify lines, levels, and centres before proceeding with formwork/falsework and ensure dimensions agree with Drawings.
- .2 Obtain geotechnical consultant's approval for use of earth forms framing openings not indicated on Drawings.
- .3 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .4 Do not place shores and mud sills on frozen ground.
- .5 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .6 Fabricate and erect formwork in accordance with CSA S269.1 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.
- .7 Align form joints and make watertight.
 - .1 Minimize the number of form joints used.
- .8 Locate horizontal form joints for exposed columns 2 400 mm above finished floor elevation.
- .9 Use 25-mm chamfer strips on external corners and 25-mm fillets at interior corners and joints, unless otherwise indicated on Drawings.
- .10 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .11 Refer to architectural Drawings for concrete members requiring architectural exposed finishes.
- .12 Build in anchors, sleeves, and other inserts required to accommodate work specified in other Sections.
 - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.

3.3 REMOVAL AND RESHORING

- .1 Leave formwork in place for the following minimum periods of time after placing concrete.
 - .1 2 days for walls and sides of beams.
 - .2 2 days for columns/piers.
 - .3 2 days for footings and abutments.
- .2 Remove formwork when concrete has reached 70 % of its 28 day design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.
- .3 Reuse formwork and falsework subject to requirements of CSA A23.1/A23.2.

3.4 SITE QUALITY CONTROL

- .1 Site Inspections:
 - .1 Professional engineer responsible for signing and stamping shop drawings to conduct on-site inspections and prepare and submit inspection reports verifying this part of the work is in accordance with Contract Documents and reviewed Shop Drawings.
 - .2 Perform inspections a minimum of 1 per month.

3.5 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 00 10 – General Requirements.

- .2 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 – General Requirements.
- .3 Waste Management: Perform in accordance with Section 01 00 10 – General Requirements.
 - .1 Once a form can no longer be used, deposit in an on-site recycling bin.

Part 1 General

1.1 SECTION INCLUDES

- .1 Reinforcing steel bars, wire fabric and accessories for Polaris University cast-in-place concrete.

1.2 RELATED REQUIREMENTS

- .1 Section 03 10 00 - Concrete Forming and Accessories
- .2 Section 03 30 00 - Cast-in-place Concrete
- .3 Section 03 35 00 - Concrete Finishing

1.3 REFERENCE STANDARDS

- .1 ASTM A1064/A1064M-18a Standard specification for carbon-steel wire and welded wire reinforcement, plain and deformed, for concrete
- .2 ASTM A123/A123M-17 Standard specification for zinc (hot-dip galvanized) coatings on iron and steel products
- .3 ASTM A184/A184M-19 Standard specification for welded deformed steel bar mats for concrete reinforcement
- .4 ASTM A1064/A1064M-18a Standard specification for carbon-steel wire and welded wire reinforcement, plain and deformed, for concrete
- .5 ASTM A416/A416M-18 Standard specification for low-relaxation, seven-wire steel strand for prestressed concrete
- .6 ASTM A1064/A1064M-18a Standard specification for carbon-steel wire and welded wire reinforcement, plain and deformed, for concrete
- .7 ASTM A704/A704M-19e1 Standard specification for welded steel plain bar or rod mats for concrete reinforcement
- .8 ASTM A775/A775M-19 Standard specification for epoxy-coated steel reinforcing bars
- .9 ASTM D3963/D3963M-21 Standard specification for fabrication and jobsite handling of epoxy-coated steel reinforcing bars
- .10 CSA A23.1:19/A23.2:19 Concrete materials and methods of concrete construction/test methods and standard practices for concrete
- .11 CSA A23.3:19 Design of concrete structure
- .12 CSA G30.18:21 Carbon steel bars for concrete reinforcement
- .13 STD G40.20/G40.21-13 (R2023) General requirements for rolled or welded structural quality steel/structural quality steel
- .14 STD S806-12 Design and construction of building structures with fibre-reinforced polymers
- .15 CSA W186:21 Welding of reinforcing bars in reinforced concrete construction
- .16 Manual of standard practice

1.4 ACTION SUBMITTALS

- .1 Section 01 00 10 – General Requirements.
- .2 Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel and wire fabric, bending and cutting schedules, supporting, and spacing devices.
- .3 Prepare and submit reinforcement drawings in accordance with RSIC Manual of Standard Practice and ACI 315.
- .4 Review of the shop drawings by the Consultant is intended to assist the Contractor and does not relieve the Contractor of responsibility for the completeness and accuracy of the work and its conformance with the contract drawings and specifications.
- .5 Fabrication that commences prior to shop drawing review by the Consultant is at the risk of the Contractor.

1.5 INFORMATIONAL SUBMITTALS

- .1 Section 01 00 10 – General Requirements.
- .2 Test Reports: Submit certified copies of mill test report of reinforcement materials analysis.

1.6 QUALITY ASSURANCE

- .1 Perform Work in accordance with Section 01 45 00 Quality Control, Maintain CSA-A23.1/A23.2 of document on site.
- .2 Provide Consultant with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
- .3 Design reinforcement under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the place where the Project is located.
- .4 Welders' Certificates: Submit to Section 01 00 10 – General Requirements, Manufacturer's Certificates, certifying welders employed on the Work, verifying CSA-qualification within the previous 12 months.

Part 2 Products

2.1 REINFORCEMENT

- .1 Reinforcing Steel, Deformed: CSA-G30.18, Grade 400W, grade deformed billet steel bars.
- .2 Welded Steel Wire Reinforcement, Plain: ASTM A1064/A1064M
- .3 Galvanized Reinforcement: Galvanized to ASTM A123/A123M, coating thickness 600g/m².

2.2 ACCESSORIES

- .1 Tie Wire:
 - .1 Minimum 1.6mm annealed type
 - .2 Patented system, manufactured approved by consultant
- .2 Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapour barrier puncture.
- .3 Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: to meet the requirements of CSA-A23.1/A23.2; size and shape as required.

2.3 FABRICATION

- .1 Fabricate concrete reinforcing in accordance with:
 - .1 CSA-A23.1/A23.2.
 - .2 ACI SP-066
 - .3 RSIC Manual of Standard Practice.
- .2 Weld reinforcement to CSA-W186.
- .3 Reinforcement: Clean surfaces, free of loose scale, dirt, oil, rust and other foreign coatings,
- .4 Reinforcement: Weld and re-protect welded joint under the requirements of CSA W186
- .5 Locate reinforcing splices not indicated on drawings, at point of minimum stress. Review location of splices with Consultant.
- .6 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.
- .7 Bundle and transport epoxy coated reinforcement in accordance with ASTM A775/A775M.
- .8 Fabricate within the following tolerances:
 - .1 Sheared Length: +/- 25 mm
 - .2 Stirrups, Ties and Spirals: +/- 10 mm
 - .3 Other Bends: +/- 25 mm
- .9 Fabrication of Galvanized Reinforcement:
 - .1 Fabricate galvanized reinforcement in accordance with ASTM A767/A767M.
 - .2 Handle galvanized reinforcement with care. Use padded contact areas on all systems for handling galvanized bars at all times, including, but not limited to, during fabrication, transportation, and placement.

- .3 Galvanize all steel supports, including support bars, to be used in conjunction with galvanized reinforcement.
- .4 The silicon content shall be either less than 0.04% or 0.15 to 0.25% inclusive when steel is to be galvanized.

Part 3 Execution

3.1 FIELD BENDING

- .1 Do not field bend or field weld reinforcement except where indicated or authorized by the Consultant.
- .2 When field bending is authorized, bending procedure shall conform to the Standard.
- .3 Replace bars which develop cracks or splits.

3.2 PLACEMENT

- .1 Place, support and secure reinforcement against displacement to CSA-A23.1/A23.2 and as indicated on reviewed placing Drawings.
- .2 Do not displace or damage vapour barrier.
- .3 Accommodate placement of formed openings.
- .4 Maintain concrete cover around reinforcing in accordance with CSA A23.1, except where indicated on the drawings.
- .5 Conform to applicable code for concrete cover over reinforcement.

3.3 FIELD QUALITY CONTROL

- .1 Inspection and Testing:
 - .1 Section 01 45 00: Quality Control.
- .2 Touch up damaged and cut ends of galvanized reinforcing steel with compatible finish to provide continuous coating.

3.4 CLEANING

- .1 Ensure concrete reinforcing is clean and free from oil and deleterious matter.
- .2 Remove all loose scale, loose rust, and other deleterious matter from surfaces of reinforcing.

3.5 SCHEDULES

- .1 Reinforcement for Foundation Wall Framing Members and Slab-on-Grade: Deformed bars and wire fabric, galvanized finish.
- .2 Reinforcement For Parking Structure Framing Members: Deformed bars, galvanized finish.

Part 1 General

1.1 SECTION INCLUDES

- .1 Reinforcing steel bars, wire fabric and accessories for cast-in-place concrete.

1.2 RELATED REQUIREMENTS

- .1 Section 03 30 00.50 - Cast-in-place Concrete - Civil

1.3 REFERENCE STANDARDS

- .1 [ASTM A1064/A1064M-22 Standard specification for carbon-steel wire and welded wire reinforcement, plain and deformed, for concrete](#)
- .2 [ASTM A123/A123M-17 Standard specification for zinc \(hot-dip galvanized\) coatings on iron and steel products](#)
- .3 [ASTM A184/A184M-19 Standard specification for welded deformed steel bar mats for concrete reinforcement](#)
- .4 [ASTM A1064/A1064M-22 Standard specification for carbon-steel wire and welded wire reinforcement, plain and deformed, for concrete](#)
- .5 [ASTM A416/A416M-18 Standard specification for low-relaxation, seven-wire steel strand for prestressed concrete](#)
- .6 [ASTM A1064/A1064M-22 Standard specification for carbon-steel wire and welded wire reinforcement, plain and deformed, for concrete](#)
- .7 [ASTM A704/A704M-19e1 Standard specification for welded steel plain bar or rod mats for concrete reinforcement](#)
- .8 [ASTM A775/A775M-22 Standard specification for epoxy-coated steel reinforcing bars](#)
- .9 [ASTM D3963/D3963M-21 Standard specification for fabrication and jobsite handling of epoxy-coated steel reinforcing bars](#)
- .10 [CSA A23.1:19/A23.2:19 Concrete materials and methods of concrete construction/test methods and standard practices for concrete](#)
- .11 [CSA A23.3:19 Design of concrete structure](#)
- .12 [CSA G30.18:21 Carbon steel bars for concrete reinforcement](#)
- .13 [STD G40.20/G40.21-13 General requirements for rolled or welded structural quality steel/structural quality steel](#)
- .14 [STD S806-12 Design and construction of building structures with fibre-reinforced polymers](#)
- .15 [CSA W186:21 Welding of reinforcing bars in reinforced concrete construction](#)
- .16 [Manual of standard practice](#)

1.4 QUALITY ASSURANCE

- .1 Provide Consultant with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
- .2 Design reinforcement under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the place where the Project is located.

- .3 Welders' Certificates: Submit to Section 01 00 10 - General Requirements, certifying welders employed on the Work, verifying CSA-qualification within the previous 12 months.

Part 2 Products

2.1 REINFORCEMENT

- .1 Reinforcing Steel, Deformed: CSA-G30.18, billet steel, Grade 400R, weldable bars, unfinished.
- .2 Welded Steel Wire Reinforcement, Plain: ASTM A1064/A1064M, in flat sheets, unfinished.

2.2 ACCESSORIES

- .1 Tie Wire:
 - .1 Epoxy coated.
 - .2 Minimum 1.65 mm annealed type
- .2 Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapour barrier puncture.

2.3 FABRICATION

- .1 Fabricate concrete reinforcing in accordance with:
 - .1 CSA-A23.1/A23.2.
 - .2 RSIC Manual of Standard Practice.
- .2 Weld reinforcement to CSA-W186.
- .3 Galvanized Reinforcement: Clean surfaces, weld and re-protect welded joint to CSA-A23.1/A23.2.
- .4 Locate reinforcing splices not indicated on drawings, at point of minimum stress. Review location of splices with Consultant.

Part 3 Execution

3.1 PLACEMENT

- .1 Place, support and secure reinforcement against displacement to CSA-A23.1/A23.2 and as indicated on reviewed placing Drawings.
- .2 Do not displace or damage vapour barrier.
- .3 Accommodate placement of formed openings.
- .4 Conform to applicable code for concrete cover over reinforcement.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Cast-in-place concrete.
- .2 Site work
- .3 Control, expansion and contraction joint devices associated with concrete work including embedments and joint sealants.

1.2 RELATED REQUIREMENTS

- .1 Section 03 05 05 – Testing of Concrete and Reinforcement.
- .2 Section 03 10 00 - Concrete Forming: Formwork and accessories.
- .3 Section 03 20 00 - Concrete Reinforcing.
- .4 Section 03 35 00 - Concrete Finishing.
- .5 Section 05 12 23 - Structural Steel for Buildings
- .6 Section 05 31 00 - Steel Decking
- .7 Section 07 92 00 - Joint Sealants.
- .8 Section 32 16 00 – Curbs, Gutters and Sidewalks
- .9 Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC): Mechanical items for casting into concrete.
- .10 Division 26 – Electrical: Electrical items for casting into concrete.

1.3 PRICE AND PAYMENT PROCEDURES

- .1 Payment for the work of this section shall be on a lump sum basis as tendered which shall be full compensation for all labour, materials, and equipment necessary to complete the work, including all subsidiary and incidental items thereto for which separate payment is not elsewhere provided.

1.4 REFERENCE STANDARDS

- .1 REP 305R-20 Guide to hot weather concreting
- .2 REP 306R-16 Guide to cold weather concreting
- .3 ASTM A820/A820M-16 Standard specification for steel fibres for fibre-reinforced concrete
- .4 ASTM B221-21 Standard specification for aluminum and aluminum-alloy extruded bars, rods, wire, profiles, and tubes
- .5 ASTM B221M-21 Standard specification for aluminum and aluminum-alloy extruded bars, rods, wire, profiles, and tubes (metric)
- .6 ASTM C260/C260M-10a(2016) Standard specification for air-entraining admixtures for concrete
- .7 ASTM C330/C330M-17a Standard specification for lightweight aggregates for structural concrete
- .8 ASTM C494/C494M-19 Standard specification for chemical admixtures for concrete
- .9 ASTM C1017/C1017M-13e1 Standard specification for chemical admixtures for use in producing flowing concrete
- .10 ASTM D412-16(2021) Standard test methods for vulcanized rubber and thermoplastic elastomers - tension
- .11 ASTM D624-00(2020) Standard test method for tear strength of conventional vulcanized rubber and thermoplastic elastomers
- .12 ASTM D994/D994M-11(2016) Standard specification for preformed expansion joint filler for concrete (bituminous type)
- .13 ASTM D1751-18 Standard specification for preformed expansion joint filler for concrete paving and structural construction (non-extruding and resilient bituminous types)
- .14 ASTM D1752-18 Standard specification for preformed sponge rubber, cork and recycled PVC expansion joint fillers for concrete paving and structural construction
- .15 CSA A23.1:19/A23.2:19 Concrete materials and methods of concrete construction/test methods and standard practices for concrete

- .16 STD A3000-18 Cementitious materials compendium

1.5 ACTION SUBMITTALS

- .1 Section 01 00 10 – General Requirements.
- .2 Product Data: Provide data on joint devices, attachment accessories, admixtures.
- .3 Samples: Submit samples of fine and coarse aggregate and all admixtures proposed for concrete mixes to the testing firm's laboratory, if requested by the Consultant.

1.6 INFORMATIONAL SUBMITTALS

- .1 Section 01 00 10 – General Requirements.
- .2 Test Data: Minimum four (4) weeks prior to starting concrete work, submit manufacturer's test data and certification by qualified independent inspection and testing laboratory that following materials will meet specified requirements:
 - .1 Portland cement.
 - .2 Blended hydraulic cement.
 - .3 Portland-limestone cement.
 - .4 Supplementary cementing materials.
 - .5 Grout.
 - .6 Admixtures.
 - .7 Aggregates.
 - .8 Water.
- .3 Minimum 4 weeks prior to starting concrete work, submit proposed quality control procedures for review by Consultant on following items:
 - .1 Hot weather concrete (air temperature above 25°C).
 - .2 Cold weather concrete (air temperature below 5°C).
 - .3 Curing.
 - .4 Finishes.
 - .5 Formwork removal.
 - .6 Floor topping.
- .4 Certification: Provide certification that mix proportions selected will produce concrete of quality, yield and strength as specified in concrete mixes, and will comply with CSA-A23.1/A23.2.
- .5 Certification: Provide certification that plant, equipment, and materials to be used in concrete comply with requirements of CSA-A23.1/A23.2.
- .6 Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent Work.
- .7 Sustainable Design:
 - .1 Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.7 CLOSEOUT SUBMITTALS

- .1 Section 01 00 10 – General Requirements.
- .2 Record Documentation: Accurately record actual locations of embedded utilities and components.
- .3 Sustainable Design Closeout Documentation:

1.8 QUALITY ASSURANCE

- .1 Perform Work in accordance with CSA-A23.1/A23.2.
- .2 Maintain one hard copy of document on site.
- .3 Acquire cement and aggregate from same source for all work.
- .4 Conform to CSA-A23.1/A23.2 when concreting during hot weather (air temperature above 25°C).
- .5 Conform to CSA-A23.1/A23.2 when concreting during cold weather (air temperature below 5°C).

Part 2 Products

2.1 CONCRETE MATERIALS

- .1 Hydraulic Cement: CSA-A3000, as noted on drawings
- .2 Fine Aggregates: Normal density aggregates, graded to CSA-A23.1/A23.2; maximum aggregate size to conform to CSA-A23-1
- .3 Coarse Aggregates: Normal density aggregates, graded to CSA-A23.1/A23.2,; maximum aggregate size to conform to CSA-A23-1
- .4 Water: CSA-A23.1/A23.2, clean and not detrimental to concrete.

2.2 ADMIXTURES

- .1 Air Entrainment: ASTM C260/C260M.
 - .1 The admixture is to be of uniform consistency and quality within each container and from shipment to shipment.
- .2 Chemical Admixtures: ASTM C494/C494M

2.3 ACCESSORIES

- .1 Shrinkage Compensating Grout: Premixed compound consisting, Portland cement, water reducing, plasticizing agents and aggregate as specified by the manufacturer.
 - .1 Compressive strength: 50MPa at 28 days.
- .2 Non-Premixed Dry Pack Grout: Composition of non metallic aggregate, Portland cement with sufficient water for mixture to retain its shape when made into a ball by hand and capable of developing compressive strength of 50MPa when measured at 28
- .3 Vapour Retarder: 0.381 (15mil) thick, type recommended for below grade application and Radon compliant.
- .4 Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 13MPa in 48 hours and 50MPa in 28 days.

2.4 JOINT DEVICES AND FILLER MATERIALS

- .1 Joint Filler Type A:, asphalt impregnated fibreboard or felt, 12.7mm thick; tongue and groove profile.

2.5 CONCRETE MIX

- .1 Mix and deliver concrete in accordance with CSA-A23.1/A23.2, Alternative 1, to the following criteria:
 - .1 Cement Type: As noted on drawings
 - .2 Class of exposure: As noted on drawings
 - .3 Compressive Strength: As noted on drawings
 - .4 Nominal size of coarse aggregate: As noted on drawings
 - .5 Slump at time and point of discharge: Per CSA-A23.1/A23.2
 - .6 Air Entrainment: Per CSA-A23.1/A23.2
- .2 Use accelerating admixtures in cold weather only when approved by Consultant. Use of admixtures will not relax cold weather placement requirements.
- .3 Use calcium chloride only when approved by consultant.
- .4 Use set retarding admixtures during hot weather only when approved by consultant.
- .5 Add air entraining agent to normal weight concrete mix for work exposed to exterior.

Part 3 Execution

3.1 EXAMINATION

- .1 Section 01 00 10 – General Requirements: Verify existing conditions before starting work.
- .2 Verify all dimensions and locations required on drawings.
- .3 Verify requirements for concrete cover over reinforcement.
- .4 Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not impede concrete placement.
- .5 Verify locations of all openings and embedments required for others work.

3.2 PREPARATION

- .1 Prepare previously placed concrete and apply bonding agent to manufacturer's written instructions.
 - .1 Prepare by:
 - .1 Mechanical roughening.
 - .2 Cleaning with steel brush.
 - .3 Sanding with abrasive wheel.
 - .4 Sand blasting to +/-6.4mm roughness.
 - .2 Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

3.3 PLACING CONCRETE

- .1 Place concrete in accordance with CSA-A23.1/A23.2.
- .2 Notify Consultant minimum twenty-four (24) hours prior to commencement of operations.
- .3 Ensure reinforcement placement and fasteners are not disturbed during concrete placement.
- .4 Install vapour retarder under interior slabs on grade. Lap joints minimum 150mm and seal watertight by approved methods. Submit to consultant for review.
- .5 Repair vapour retarder damaged during placement of concrete reinforcing. Repair with vapour retarder material; lap over damaged areas minimum 150mm and seal watertight.
- .6 Water Stops.
 - .1 Install water stops to provide continuous watertight seal.
 - .2 Do not distort or pierce water stop in such a way as to hamper performance.
 - .3 Do not displace reinforcement when installing water stops.
 - .4 Use equipment to manufacturer's requirements to field splice water stops.
 - .5 Tie water stops rigidly in place.
 - .6 Use only straight heat sealed butt joints in field.
 - .7 Use factory welded corners and intersections.
- .7 Install joint per structural drawing details
- .8 Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- .9 Place concrete continuously between predetermined expansion, control, and construction joints.
- .10 Do not interrupt successive placement; do not permit cold joints to occur.
- .11 Saw cut joints within twelve (12) hours after placing. Use 3.2mm thick blade, cut minimum 1/4 depth of slab thickness (Max 50mm).
- .12 Surface flatness per structural drawings.

3.4 SEPARATE FLOOR TOPPINGS

- .1 Place monolithic topping before base course has completely set, to CSA-A23.1/A23.2.
- .2 Prior to placing bonded concrete topping, roughen substrate concrete surface and remove deleterious material to CSA-A23.1/A23.2. Broom and vacuum clean.
- .3 Place required equipment anchors and other items to be cast into concrete.
- .4 Place concrete floor toppings to required lines and levels.
- .5 Place concrete floor topping in checkerboard panels, dimension not to exceed. 5m x 5m

3.5 TOLERANCES

- .1 Slab and Floor Tolerances: To CSA-A23.1/A23.2, using F-number method, see drawings for tolerance

3.6 CONCRETE FINISHING

- .1 Finish concrete floor surfaces to requirements of Section 03 35 00.
- .2 Finish concrete floor surfaces in accordance with CSA-A23.1/A23.2.
- .3 In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains

3.7 CURING AND PROTECTION

- .1 Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical damage.
- .2 Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- .3 Cure concrete floor surfaces to requirements of Section 01 00 10.
- .4 Cure floor surfaces in accordance with CSA-A23.1/A23.2.
- .5 Ponding: Maintain 100% coverage of water over floor slab areas continuously for four (4) days.
- .6 Spraying: Spray water over floor slab areas and maintain wet cure for seven (7) days.

3.8 FIELD QUALITY CONTROL

- .1 Inspection and Testing: See Section 03 05 05

3.9 PATCHING

- .1 Allow Consultant to inspect concrete surfaces immediately upon removal of forms.
- .2 Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Consultant upon discovery.

3.10 DEFECTIVE CONCRETE

- .1 Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- .2 Repair or replacement of defective concrete will be determined by the Consultant.
- .3 Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Consultant for each individual area.

3.12 SCHEDULE - JOINT FILLERS

- .1 Exterior Retaining Wall at Entracen Ramps: Joint filler Type F recessed 10mm with sealant cover.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 20 00.50 - Concrete Reinforcing - Civil
- .2 Section 32 16 00 - Curbs, Gutters and Sidewalks

1.2 ABBREVIATIONS AND ACRONYMS

- .1 Portland Cement: hydraulic cement, blended hydraulic cement (XXb - b denotes blended) and Portland-limestone cement types:
 - .1 GU, GUb, GUL and GULb - General use cement
 - .2 MS, MSb and MSLB - Moderate sulphate-resistant cement
 - .3 MH, MHb, MHL and MSLB - Moderate heat of hydration cement
 - .4 HE, HEb, HEL and HELb - High early-strength cement
 - .5 LH, LHb, LHL LHLb - Low heat of hydration cement
 - .6 HS, HSb and HSLb - High sulphate-resistant cement
- .2 Fly ash types:
 - .1 F - with a maximum CaO content of 8%
 - .2 CI - with CaO content of 15% and 20%
 - .3 CH - with a minimum CaO content of 20%
- .3 Other Supplementary Cementitious Materials (SCM) types:
 - .1 S-GGBFS - Ground, granulated blast-furnace slag
 - .2 N - Natural pozzolan
 - .3 SF - Silica fume with minimum silicon dioxide (SiO_2) content of 85%
 - .4 SFI - Silica fume with silicon dioxide (SiO_2) content between 75% and 85%
 - .5 GL - Ground glass with maximum total alkali (NaEq) content of 4%
 - .6 GH - Ground glass with total alkali (NaEq) content between 4% and 13%

1.3 REFERENCE STANDARDS

- .1 ASTM International (ASTM):
 - .1 [ASTM C260/C260M-10a](#), Standard Specification for Air-Entraining Admixtures for Concrete
 - .2 [ASTM C309-19](#), Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - .3 [ASTM C494/C494M-17](#), Standard Specification for Chemical Admixtures for Concrete
 - .4 [ASTM C881/C881M-20a](#), Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 - .5 [ASTM C1017/C1017M-13e1](#), Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
 - .6 [ASTM C1059/C1059M-21](#), Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete

- .7 [ASTM D412-16](#), Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
- .8 [ASTM D624- 00](#), Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
- .9 [ASTM D1751- 18](#), Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- .10 [ASTM D1752- 18](#), Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
- .2 CSA Group (CSA):
 - .1 [CSA A23.1: 19 /A23.2: 19](#), Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
 - .2 [CSA A283: 19](#), Qualification Code for Concrete Testing Laboratories
 - .3 [CSA A3000- 18](#), Cementitious Materials Compendium

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, product literature and data sheets for proprietary materials used in cast-in-place concrete and additives and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Contractor shall be responsible for and pay for design of concrete mixes. Design of concrete mixes shall be performed by a Testing Laboratory selected by the Contractor. Design methods to be in accordance with CAN/CSA-23.1/A23.2
- .3 Site Quality Control Submittals:
 - .1 Make trial mixes using aggregate proposed or provide design for approval.
 - .2 Make advance tests of trial mixes with proposed materials. Test four cylinders in accordance with CAN/CSA-A23.1/A23.2 at 7 days and 28 days. Do not place concrete on project until laboratory reports and breaks of confirmation cylinders indicate that proposed mixes will develop required strengths.
 - .3 Check mix design and revise, if necessary, wherever changes are made in aggregate or in surface water content of aggregate or workability of concrete. Slump shall be the minimum to produce workable mix. Laboratory shall prescribe minimum quantity of water.
 - .4 If Portland Cement reducers or other additives are used, submit control mix design without reducers or additives as well as mix exactly proposed to be used.
 - .5 Forward two copies of design mix to Engineer for approval.
 - .6 Provide testing result reports for review by Consultant do not proceed without written approval when deviations from mix design or parameters found.
 - .7 Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken.
 - .8 Concrete hauling time: provide for review by Consultant exceeding maximum allowable time of 60 minutes for concrete delivered to site of Work and discharged after batching.

- .4 Samples
 - .1 Minimum 4 weeks prior to beginning Work, submit 2 samples for review and acceptance of materials proposed for use as follows:
 - .1 5 L of curing compound.
 - .2 2 m length of each type of joint filler.
 - .3 3 kg of each type of supplementary cementing material.
 - .4 10 kg of each type of blended hydraulic cement.
 - .5 5 kg of each admixture.
 - .6 23 kg of each fine and coarse aggregate.
 - .2 Samples returned for inclusion into work.

1.5 QUALITY ASSURANCE

- .1 Quality Assurance: In accordance with Section 01 00 10 - General Requirements.
- .2 Provide Consultant minimum 4 weeks prior to starting concrete work, with a valid and recognized certificate from plant delivering concrete.
 - .1 Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture meet specified requirements.
- .3 At least 4 weeks prior to beginning Work, inform Consultant of source of fly ash.
 - .1 changing source of fly ash without written approval of Consultant is prohibited.
- .4 Submit proposed quality control procedures a minimum four weeks before starting concrete work, for review by Consultant on the following items:
 - .1 Falsework erection
 - .2 Hot weather concrete
 - .3 Cold weather concrete
 - .4 Curing
 - .5 Finishes
 - .6 Formwork removal
 - .7 Joints
- .5 Quality Control Plan: Submit written report to Consultant verifying compliance that cast-in-place concrete meets performance requirements of concrete as established in PRODUCTS in Part 2 of this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Concrete hauling time: Deliver to site of Work and discharge within a maximum of 60 minutes after batching.
 - .2 Modifying maximum time limit without written agreement from Consultant and concrete producer as described in CSA A23.1/CSA A23.2 is prohibited.
 - .3 Submit deviations for review by Consultant.
 - .4 Concrete delivery: Ensure continuous concrete delivery from plant meets CSA A23.1/CSA A23.2.

1.7 SITE CONDITIONS

- .1 Placing concrete during rain or weather events that could damage concrete is prohibited.
- .2 Protect newly placed concrete from rain or weather events in accordance with CSA A23.1/CSA A23.2
- .3 Cold weather protection:
 - .1 Maintain protection equipment in readiness on Site.
 - .2 Use protection equipment when ambient temperature is below 5°C, or when temperature may fall below 5°C before concrete has cured.
 - .3 Placing concrete upon or against surface at temperature below 5°C is prohibited.
- .4 Hot weather protection:
 - .1 Protect concrete from direct sunlight when ambient temperature is above 27°C.
 - .2 Prevent forms from getting too hot before concrete is placed. Apply accepted methods of cooling that will not negatively affect concrete.
- .5 Protect concrete from drying.
- .6 Coordination:
 - .1 Coordination schedules of concrete pours to allow adequate time for installation of other related work.
 - .2 Coordinate earthwork and soils report requirements with placement requirements
 - .3 Coordinate with form-work and finishes sections to provide slopes as specified on contract documents

Part 2 Products

2.1 PERFORMANCE CRITERIA

- .1 Quality Control Plan: ensure concrete supplier meets performance criteria of concrete as established by Consultant and provide verification of compliance as described in PART 1 - QUALITY ASSURANCE.

2.2 MATERIALS

- .1 Portland Cement: CAN/CSA-A3001, Type GU
- .2 Concrete for curb, gutter, and sidewalk is to be C-2 Exposure Class Concrete.
- .3 Aggregates: Clean, hard, durable, uncoated.
 - .1 Fine Aggregate is to meet the requirements of CSA A23.1 - Table 10
 - .2 Coarse aggregate is to meet the requirements of CSA A23.1 - Table 11
 - .3 Blended aggregates should also meet the physical requirements of CSA Standard A23.1 - Table 12
- .4 Water: To CSA A23.1/CSA A23.2 - potable.
- .5 Proportions and Mixing
 - .1 Proportions and Design: In accordance with approved mix design.
 - .1 Min All. Comp.
 - .2 Strength (28 days)

- .3 35 MPa
- .2 Admixture: No admixtures without approval. Introduce admixtures in quantities and according to methods recommended by admixture manufacturer. Add air-entraining agent to concrete as scheduled.
- .3 Slump: Not to exceed 40mm
- .4 Mixing Ready mixed concrete in accordance with CAN/CSA-A23.1/A23.2. Do not transport or use concrete after 1-1/2 hours have elapsed from time of initial mixing. Supplier of transit-mixed concrete shall have a plant of sufficient capacity, and adequate transportation facilities to assure continuous delivery at required rate, to provide continuous concrete placement throughout a pour.
- .5 Dry Pack: Non-Shrink, Non-Metallic: Five Star® Grout by Five Star Products, Inc., ASTM C-877, C-191, and C-109, 5,000 PSI.
- .6 Air content of the concrete is to be maintained between the limits of 5 to 8%.
- .6 Curing materials
 - .1 Water: Domestic Quality, clear and potable with no chemical content.
 - .2 Sheet Material: ASTM C171. Moisture loss maximum .055 g/ cm sq.
 - .3 Colour Natural Gray (no color)
 - .4 Curing Compounds: Ashford Formula™ Curecrete by Curecrete Distribution, Inc., or equal.

Part 3 Execution

3.1 PREPARATION

- .1 Obtain Consultant's written approval before placing concrete.
 - .1 Provide a minimum of 24 hours notice before placing of concrete.
- .2 During concreting operations:
 - .1 Development of cold joints not allowed.
 - .2 Ensure concrete delivery and handling facilitate placing with minimum amount of re-handling, and without damage to existing structure or Work.
- .3 Pumping of concrete permitted only after approval of equipment and mix.
- .4 Disturbing reinforcement and inserts during concrete placement is prohibited.
- .5 Before placing of concrete obtain Consultant's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .6 Protect previous work from staining.
- .7 Clean and remove stains before application for concrete finishes.
- .8 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, workability, air content, temperature and test samples taken.
- .9 In locations where new concrete is dowelled to existing work, drill holes in existing concrete.
 - .1 Place steel dowels of deformed steel reinforcing bars and pack solidly with epoxy grout to anchor and hold dowels in positions as indicated.
- .10 Do not place load upon new concrete until authorized by Consultant.

- .11 Subgrade for sidewalks, curbs, and driveways is to be excavated and prepared to the lines and cross-sections on the plans or as designated by the Consultant. Unsuitable material is to be removed and replaced as designated by the Consultant. The subgrade is to be uniformly compacted to provide a firm base for all concrete and paving stone work. Subgrade, subbase, and levelling courses are to be compacted at the optimum moisture content to 98% of Standard Proctor Density. The subgrade and sub-base elevation are to be finished to tolerances requiring zero to 25 mm of levelling course material. This material is to be compacted by means of vibratory compactor. Vertical or sloping faces are to be cut within 25 mm of the proposed back of curb. This cut is to be formed in material compacted to 98% Standard Proctor Density. When curb and gutter are placed on compacted gravel, crushed gravel meeting the gradation limited presented in City of Whitehorse SSM Part 3 - Specifications Section 3.15.2.3 may be used for fine grading. Any gravel fill is to be compacted near the optimum moisture content to 98% Standard Proctor Density.

3.2 INSTALLATION/APPLICATION

- .1 Do cast-in-place concrete work in accordance with CSA A23.1/CSA A23.2.
- .2 Placing Concrete:
 - .1 Convey and place concrete allowing no separation of ingredients in accordance with ACI 304 and as specified below.
 - .2 Maximum height of concrete free fall: five-feet.
 - .3 Regulate rate of placement to maintain plasticity and flow into position.
 - .4 Deposit concrete continuously until panel or section is completed.
 - .5 Place concrete in horizontal layers 18" maximum thickness.
- .3 Consolidation
 - .1 Use mechanical vibrating equipment for consolidation.
 - .2 Vertically insert and remove hand-held vibrators at 18" o.c. for 10 to 15 seconds
 - .3 Do not use vibrators to transport concrete in forms.
 - .4 Provide vibrators with minimum speed of 8000 RPM and with amplitude to consolidate effectively.
 - .5 Thoroughly consolidate concrete and work around reinforcement, embedded items and into corners of forms. Thoroughly consolidate layers of concrete with previous layers.
- .4 Finish:
 - .1 Smooth Trowel
- .5 Cracking
 - .1 Cracking from inadequate curing is not allowed. Sawcut joints and construction joints are shown on drawings. Contractor may, with approval of Resident Project Representative, recommend and detail other joints required to prevent cracking.
- .6 The concrete is to be placed within 1.5 hours of initial mixing at the plant. Complete discharge of concrete is not to exceed two hours. The concrete is to be transported by a method that prevents segregation and deposited on the subgrade so that as little handling as possible is required.
- .7 Concrete is to be placed continuously until a complete section between expansion joints has been poured.

- .8 Concrete is not to be placed until the condition of the subgrade has been inspected with the Consultant. The subgrade is to be sufficiently moist to prevent absorption of water from the concrete, and free from mud or water ponding.
- .9 The concrete is to be thoroughly consolidated against and along the faces of the forms. Hand spreading is to be done with shovels, not with rakes, in order that the concrete will not be segregated. Precautions should be taken to prevent overworking of the concrete.
- .10 Concrete is to be handled from the mixer to the place of final deposit as rapidly as practicable by methods, which is to prevent the separation or loss of the ingredients. It is to be deposited in the forms as near as practicable to its final position to avoid re-handling.
- .11 The sequence of concrete placement is to be arranged so that concrete, which has partially hardened, is not to be subjected to injurious vibration.
- .12 The vertical free fall height of concrete is not to exceed 1.0m. For falls greater than 1.0m, chutes or tremies are to be used.
- .13 During placement, concrete is to be sufficiently tamped or vibrated with suitable equipment to secure a close bond with the reinforcement, eliminate entrapped air voids, and ensure a homogeneous structure with adequate consolidation.
- .14 Concrete is to be placed and vibrated to form curbs, gutters and sidewalks in accordance with the standard drawings in City of Whitehorse Servicing Standards Manual - Section 4.
- .15 The rate of delivery of mixed concrete is to be such that the interval between the placing of successive truckloads are not to exceed 30 minutes. If the time exceeds 30 minutes, then a construction joint is to be formed at the end of pour.
- .16 After the initial set of the concrete, neither the forms nor the concrete structure are to be jarred and no strain is to be placed on the ends of projecting reinforcement.
- .17 Backfilling behind the curb, gutter and sidewalk is to be carried out 7 days after form removal and is to be compacted to a minimum of 98% Standard Proctor Density.
- .18 Joints
 - .1 Curb, gutter and sidewalk contraction joints are to be constructed at 3.0 m intervals (as detailed on the standard drawings in City of Whitehorse Servicing Standards Manual - Section 4) and are not to be less than 50 mm deep. Midway between each contraction joint on the sidewalk, a surface joint, 13 mm deep, is to be constructed. These joints are not to extend through the curb and gutter. Contraction joint widths are not to be greater than 5 mm.
 - .2 A surface joint is to be constructed longitudinally at the location shown on the standard drawings in City of Whitehorse Servicing Standards Manual - Section 4 and is to continue through all driveways and lane crossings.
 - .3 A construction joint is to be formed at the end of every pour. This joint is to be constructed in a "V" shape, as directed by the Consultant.
 - .4 The joint spacing at the end of a pour may vary from that specified by the following:
 - .1 If the end of the pour falls within 300 mm of the required joint spacing, the distance between the last two joints are to be averaged.
 - .2 If the end of the pour falls within 800 mm of the required joint spacing, the distance between the last three joints are to be averaged. In special

cases, the location of the end of the pour is to be as specified by the Consultant.

- .5 When it is necessary to construct longitudinal construction joints in a walk, 10 M bars 600 mm long are to be placed transverse to the joint every meter and penetrate each slab by 300 mm.
 - .6 Where a sidewalk or divider is to be constructed abutting existing curb, a 10 mm wide by 30 mm deep slot is to be formed between the back of the curb and the walk or divider. This slot is to be filled with the joint filler specified in Section 3.15.2.2.6. 10 M bars at 500 mm on center are to be dowelled and epoxied into the back of the existing curb prior to placing concrete.
- .19 Finishing
- .1 Sidewalk surfaces, either separate or combined with curb and gutter, are to be struck off and screeded to the slope, cross-section and elevation shown on the drawings and as staked by the Consultant. The surface is to be consolidated and smoothed using a wood float. Light-steel troweling is to be used followed by a uniform brush finish. Sidewalk is to be edged at all joints to prevent chipping of the concrete.
 - .2 The exposed surfaces of concrete curbs and gutters, either separate or monolithic with sidewalks, are to be finished by means of a wood floating, light-steel troweling, and uniform brushing, and all edges are to be rounded to the required radius. No patching will be allowed.
 - .3 Crossings to lanes and private property are to be struck off and screeded to the required slope and cross section. The finished surface is to be brushed as specified above.
 - .4 All edges, including contraction or surface joints, are to be tooled for a width of 50 mm and rounded to a radius of 6 mm. The brush grooves are to be transverse on the sidewalk and longitudinal on the curb and gutter. The finished surface is to have no exposed aggregate or honeycomb.
 - .5 If there is evidence of excess water on the concrete surface, finishing is to be delayed until the excess water has evaporated.
 - .6 Surface grooves made by the broom are not to be more than 3 mm deep. Before brushing, all surplus water is to be removed from the brush.
- .20 Backfilling
- .1 Unless otherwise directed by the Consultant, the Contractor is to backfill along the back of the curb edges, to the top of the concrete after 3 days of the placing of the concrete. The backfill is to be mechanically tamped in maximum lifts of 150 mm, to a minimum of 98% Standard Proctor Density and to a distance of 300 mm from the back of the walk or curb. Where landscaping is to be carried out immediately after completion of the walks or curbs and gutters, the backfilling is to be left 100 mm low to allow for the topsoil.
- .21 Curing
- .1 Immediately after finishing, the concrete surface is to be protected by applying an approved membrane curing compound. Immediately after removal of the forms, all exposed surfaces are to be thoroughly wetted with water and then sprayed with membrane curing compound. The membrane-curing compound is to be applied in accordance with the manufacturer's instructions.

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- .2 The curing compound is to be applied under pressure with a spray nozzle in a manner that thoroughly and completely covers the entire surface with a uniform film at a rate which dependent on the roughness of the surface of the concrete. At no case is the rate of application to be less than 0.25 litres per square meter of concrete surface.
- .22 Mechanical Extruding Materials
- .1 If an extruding machine is used in constructing curbs, curb and gutter, sidewalk or combined curb and sidewalk, the material excavated to accommodate the machine is to be either stockpiled at a specified location or windrowed to the center of the street with a minimal disruption to traffic. After the installation of the concrete works, the excavated material is to be replaced to the original street grade or to the elevations designated by the Consultant and compacted to not less than the specified Standard Proctor Density at optimum moisture content. Any granular material, which may have existed, is to be replaced on the street. Backfill material required behind curbs or sidewalks is to be hauled in from surplus stockpiles or from a location designated by the Consultant. Appurtenances are to be located, examined for deficiencies, and staked by the prior to work beginning on a particular section, and any deficiencies noted are to be reported to the Consultant immediately.
- .2 Upon completion of a block of work, the structures are to be relocated and inspected with the Consultant.
- .3 The Developer is to repair any damage, which may have occurred during the concreting operations as well as any deficiencies not previously reported to the Consultant.
- .4 When using extruding equipment, the requirements below apply in addition to those in Section 3.15.2. Slip-form paving machines or concrete, extruding machines may be used for placing concrete provided they meet the following requirements and have received the approval of the Consultant prior to commencement of the work:
- .1 The vibrators on the equipment are to be capable of producing a dense mass with a smooth surface, free of honeycombing.
- .2 The equipment is to include automatic grade and line controls, which is to be used at all times.
- .5 Any special grading or preparation of the clay or gravel base required by the Contractor to accommodate his equipment is to be the responsibility of the Contractor, and they are to restore the roadway and boulevards to their original condition within 10 days of the initial disturbance. The Contractor is to replace any gravel base contaminated by clay or other material.
- .6 Whenever possible the forming and placing of concrete by conventional methods (as may be required at corners, driveways and catch basins), is to be carried out in conjunction with the extruding machine operation. Where this procedure is not practical, the "tie-ins" are to be completed within 3 days of construction of the adjacent extruded section. The hand pours of the said "tie-ins" are to be completed in one continuous pour.
- .23 Hand Forming
- .1 Forming
- .1 Forms are to be of steel or wood of sufficient strength to resist the pressure of wet concrete, and the supply is to be sufficient to permit their

- remaining in place until hydration has occurred, or longer if the Consultant considers it necessary. The Developer is to remove all face forms to allow for a smooth brush finish. The use of bent, twisted, battered or worn-out forms will not be permitted. The Consultant will check forms for alignment and elevation before concrete is poured, and is to ensure they are cleaned and oiled before each use.
- .2 Where required, reinforcement is to be secured in the location shown on the standard drawings in the City of Whitehorse Servicing Standards Manual - Section 4 and is to be free from mill scale, grease and rust prior to placing concrete. Forms are to be held securely by approved methods to prevent movement and bulging when the concrete is placed. The Consultant or his representative must approve forms before concrete is poured.
 - .3 Curbs having a radius of less than 40 m are to be constructed with flexible forms. A sufficient length of form (not less than 50 meters) are to be placed and checked before concrete is poured to ensure true line and grade. The forms are to be well staked, braced, or otherwise held rigidly true to the established line and grade. The Consultant may, at any time, reject the use of any forms he considers unsatisfactory.
- .2 Consolidation
 - .1 The concrete is to be consolidated by means of an approved vibrating screed or, in the case of curb and gutter only, by means of a poker or pencil vibrator not exceeding 50 mm in diameter.
 - .2 Particular care is to be given to placing and tamping along the faces of the forms to ensure a dense, smooth surface.
 - .3 Vibrations are to be of sufficient duration to thoroughly compact the concrete but not long enough to cause segregation. Vibrators are not to be used for moving concrete.
 - .3 Cold Weather Requirements
 - .1 When the temperature of the surrounding atmosphere is at or below 5 degrees Celsius, the aggregate and the mixing water are to be heated. The aggregate and mixing water are to have a temperature of not less than 5 degrees Celsius and be entirely free of frozen materials. The aggregate is not to be heated to more than 60 degrees Celsius, and the concrete when deposited in the forms is to have a temperature of not less than 10 degrees Celsius nor more than 38 degrees Celsius. The concrete is to be maintained at a temperature of 10 degrees Celsius for not less than 4 days after placing.
 - .2 Concrete may have to be protected from cold weather during the hydration stage. Requirements are to be determined based on expected air temperatures and wind velocity, the size and shape of the concrete element and the amount of cementitious material in the concrete mix.
 - .4 Protection
 - .1 The Developer is to be responsible for keeping all animals and pedestrians off the newly constructed sidewalks or curb until completely set. The Contractor is also to be responsible for keeping all vehicles off the work for a period of 3 days after the concrete has been finished.

3.3 TOLERANCES

- .1 Concrete surface tolerance to CSA A23.1/CSA A23.2 to tolerance schedule as indicated on contract Specifications.
- .2 The Contractor with a 3 m straightedge is to check all exposed concrete surfaces, and any water pockets or deviations in line or grade exceeding a total of 3 mm is to be corrected immediately.
- .3 Differences in elevation at any given point from that given by the design are not to exceed 13 mm, and the maximum variation is not to be greater than 13 mm.
- .4 Deviations in horizontal alignment at any given point from that given by the design are not to exceed 25 mm, and the fluctuations in the horizontal alignment are not to be greater than 25 mm.
- .5 Concrete not meeting the above criteria is to be replaced.

3.4 SITE QUALITY CONTROL

- .1 A qualified testing laboratory in accordance with the following is to perform testing:
 - .1 Samples of concrete are to be obtained in accordance with CSA Test Method A23.2-1C for sampling plastic concrete.
 - .2 Test cylinders are to be made and stored in accordance with CSA Test Method A23.2-3C for making and curing concrete compressive and flexural test specimens. No less than one strength test is to be made from samples from each 150 cubic meters of concrete placed, and in no case, is there to be less than one test from each day's pour. Each strength test is to consist of three test cylinders, 1 tested at 7 days and 2 at 28 days. All test cylinders representing concrete placed after September 15 are to be tested at 7 days. When the cold weather requirements of Section 3.15.2.9 are in place 4 cylinders are to be cast with one cured in the field. The fourth cylinder is to be field cured in the same manner as the actual concrete for 7 days and is to be broken at 7 days.
 - .3 Compressive strength determination is to be in accordance with CSA A23.2-9C.
 - .4 Compression Test Specimens: Standard method of making and curing concrete test specimens in the field in accordance with ASTM C31
 - .5 Air content determinations are to be made in accordance with CSA Test Method A23.2-4C, Air content of plastic concrete by the pressure method.
 - .6 Slump: Standard method of testing slump of Portland cement concrete in accordance with CSA A23.2-5C.
 - .7 Sampling Fresh Concrete: Standard method of sampling fresh concrete in accordance with CSA A23.2-1C.
- .2 During construction start-up, every load or batch of concrete is to be tested until satisfactory control of the air content has been established. Air content tests taken with the test cylinders will be sufficient once satisfactory control has been established. Whenever a test falls outside the specified limits, the testing frequency is to revert to one test per load or batch until satisfactory control is re-established. Any concrete that falls outside specified air control levels in accordance with this Section is to be rejected from use.
- .3 Slump tests made in accordance with CSA Test Method A23.2-5C, Slump of Concrete, is to be made in conjunction with each strength test.

3.5 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements.
 - .1 Provide appropriate area on Project site where concrete trucks can be safely washed.
- .2 Waste Management: Separate waste materials for reuse or recycling.
 - .1 Divert unused concrete materials from landfill to local facility after receipt of written approval of consultant.
 - .2 Divert unused admixtures and additive materials (pigments, fibres) from landfill to official hazardous material collections site.
 - .3 Disposal of unused admixtures and additive materials, concrete, concrete washwater, or cleaning materials and residues into sewer systems, into lakes, streams, onto ground or in other locations that pose a health or environmental hazard is prohibited.
 - .4 Prevent admixtures and additive materials from entering drinking water supplies or streams.
 - .5 Using appropriate safety precautions, collect liquid or solidify liquid with inert, noncombustible material and remove for disposal.
 - .6 Dispose of waste in accordance with applicable local, Provincial/Territorial and National regulations

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide concrete finishing in accordance with requirements of the Contract Documents.

1.2 Definitions

- .1 Floor Classifications: Classification of concrete floor slabs based on their intended use, methods of finishing and finish materials applied to flooring as denoted by the F-rating below, and as follows:

.1 Single Course Floor: Floors placed in a single course with final finishing applied to properly levelled concrete.

- .2 Finish or Finishes: Materials applied to finished concrete surface, i.e.: stained or coloured concrete, carpet, resilient flooring or ceramic tile.

- .3 Finishing: Methods, tools and equipment employed to achieve levelness or surface flatness for shored slabs and slabs-on-grade, and durability indicated and as follows: Finishing: Methods, tools and equipment employed to achieve levelness or surface flatness for shored slabs and slabs-on-grade, and durability indicated and as follows: F_L doesn't apply to suspended slabs.

.1 F1-Finishing: Floors having a straightedge value of ± 8 mm over 3050 mm; Floors having an overall F-number of $F_F 20 \times F_L 15$; similar to CSA A23.1 Class A Slab Finishing.

.1 Locations; Non-Critical or Parkade Floors: Non-critical floor slabs include mechanical rooms, non-public areas, surfaces having raised computer flooring, surfaces that have thick-set tile, and parking structure slabs.

.2 F2-Finishing: Floors having a straightedge value of ± 6 mm over 3050 mm; Floors having an overall F-number of $F_F 25 \times F_L 20$; similar to CSA A23.1 Class B Slab Finishing.

.1 Locations; Light Duty Industrial or Commercial Floors: Slabs having carpeted finish for Institutional or Commercial floors.

.3 F3-Finishing: Floors having a straightedge value of ± 5 mm over 3050 mm; Floors having an overall F-number of $F_F 30 \times F_L 25$; similar to CSA A23.1 Class C Slab Finishing.

.1 Locations; Flat Institutional or Commercial Floors: Slabs having thin set tile and resilient tile floor finish for Institutional or Commercial floors.

1.3 References

- .1 American Concrete Institute (ACI):

.1 ACI 302.1R, Guide for Concrete Floor and Slab Construction

- .2 CSA Group (CSA):

.1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction

- .3 International Concrete Repair Institute (ICRI):

.1 ICRI 310.2, Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings and Polymer Overlays

1.4 Administrative Requirements

- .1 Coordination: Coordinate a meeting between Contractor, Subcontractor responsible for concrete placement, and the Consultant to determine Site Quality Control testing section borders and sample measurement line locations, method of measurement, and accuracy requirements of the measuring devices.

- .2 Pre-Construction Meetings: Arrange meeting with Contractor, Subcontractor for work of this Section and other Subcontractors affected by work of this Section to discuss effects and issues governing installation of concrete finishing materials; prepare an outline agenda for meeting.

1.5 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory used in the work.
 - .1 Furnish information for each type of cement, aggregate, admixture, curing, finishing, levelling and densifying material.
 - .2 Submit manufacturer's product data for each materials specified including recommended application rates and methods of installation.
- .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings for the fabrication and installation of the Work. Show the location of construction joints, and the locations of Work required by other trades with details and templates for placement and spacing, including openings, penetrations, depressions, slopes, curbs, equipment pads, sleeves, embedments, inserts and blockouts.
- .3 Repair Procedures: Submit for Consultant's information. Procedural outline of proposed repair work including a description of materials, preparation, and protection.

1.6 Quality Assurance

- .1 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Installers: Use skilled workmen experienced in concrete finishing methods similar in complexity and extent to that required for the Work of the Contract.

1.7 Project Closeout Submissions

- .1 Operation and Maintenance Data: Submit detailed cleaning and maintenance instructions for concrete densifier products, and instruct Owner in proper care and maintenance of specified floor finishes, including a complete list of floor care products that will be required for on-going maintenance.
- .2 Maintenance Materials: Leave a minimum of one (1) 18.9 L container of maintenance coating, and remaining portion of coating from first treatment, stored on site at location directed by Owner.

1.8 Quality Assurance

- .1 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Installers: Use skilled workmen experienced in concrete finishing methods similar in complexity and extent to that required for the Work of the Contract.

2. PRODUCTS

2.1 Materials

- .1 Concrete Formwork: Refer to Structural Drawings.
- .2 Concrete Materials and Reinforcement: Specified in accordance with Structural Drawings.

2.2 Levelling Materials

- .1 Underlayment: Cementitious, self levelling, single component, polymer modified underlayment and manufacturer's recommended primer, for application thicknesses to a minimum feather edge to 13 mm; acceptable materials as follows:
 - .1 UZIN NC 150
 - .2 ARDEX Engineered Cements; ARDEX V1200
 - .3 Custom Building Products, CustomTech TechLevel XP-1
 - .4 MAPEI Canada Inc., Novoplan 2 Plus
 - .5 Sika Canada Ltd., Sikafloor Level 25 CA

- .6 W.R. Meadows of Canada, Floor Top STG
 - .2 Patching and Flash Patching Materials: Cementitious based, polymer modified, fine aggregate, single component, rapid curing, early strength floor patching compounds having high adhesion, for application in thicknesses to a minimum of 4 mm to 25 mm; acceptable materials as follows:
 - .1 ARDEX MRF
 - .2 UZIN NC 886 or UZIN NC 888
 - .3 MAPEI Canada Inc., Mapicem 101
 - .4 Sika Canada Ltd., SikaQuick 1000
 - .5 W.R. Meadows of Canada, Sealtight Meadow-Crete H
 - .3 Cementitious Moisture Reduction Barrier Materials: Two-component, polymer-modified, cementitious based waterproofing slurry topping; formulated to reduce water infiltration; applicable from 2 mm to 4 mm; acceptable materials as follows:
 - .1 UZIN PE 460 with UZIN PE280 primer
 - .2 ARDEX Engineered Cements; ARDEX MC Rapid
 - .3 Custom Building Products, CustomTech TechMVC
 - .4 MAPEI Canada Inc., Planiseal VS
 - .5 Sika Canada Ltd., Epocem 81
- 2.3 Hardeners/Densifier
- .1 Liquid Applied Floor Hardener Materials (Concrete Densifier): Water based, sodium silicate type or lithium silicate type, chemically reactive, permanent treatment, penetrating sealer and hardener; non-toxic, non-flammable, surface densification and anti-dusting treatment having less than 0 g/L VOC:
 - .1 Location: indicated on Drawings as Sealed Concrete.
 - .2 Acceptable materials – Sodium Silicate:
 - .1 Curecrete, Ashford Formula
 - .2 Euclid Chemical Company, Euco Diamond Hard
 - .3 MAPEI, Mapecrete Hard SB
 - .4 Sika Canada, Sikafloor 3S
 - .5 W.R. Meadows of Western Canada, Liquid-Hard
 - .3 Acceptable materials – Lithium Silicate:
 - .1 Master Builders Solutions, MasterTop CC 733
 - .2 Sika Canada, SikaFloor Curehard LI
 - .3 Mapei Mapecrete Hard LI
 - .4 W.R. Meadows of Western Canada, Liquid-Hard Ultra

3. EXECUTION

3.1 Finishing Floors and Slabs

- .1 Finish floors and slabs in accordance with CSA A23.1 and ACI 302.1R recommendations for screeding, re-straightening, and finishing operations for concrete surfaces; do not wet concrete surfaces.
- .2 Float (Initial) Finishing:
 - .1 Consolidate surface with power driven floats or by hand floating if area is small or inaccessible to power driven floats.
 - .2 Re-straighten, cut down high spots, and fill low spots.
 - .3 Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.
 - .4 Apply float finishing to surfaces receiving trowel finishing.

- .3 Trowel (Final) Finishing:
 - .1 Commence trowel finishing after all bleed water has disappeared and when the concrete has stiffened sufficiently to prevent the working of excess mortar to the surface.
 - .2 Apply first trowelling and consolidate concrete by hand or power-driven trowel after applying float finishing; continue trowelling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance; repair or smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - .3 Apply a trowel finishing to surfaces exposed to view or to be covered with resilient flooring, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 - .4 Finish surfaces to the tolerances indicated in item 1.2.3 above.
- .4 Trowel and Fine Broom Finishing:
 - .1 Apply trowel finishing to surfaces indicated.
 - .2 Slightly scarify surface with a fine broom While concrete is still plastic.
 - .3 Finish surfaces to the tolerances indicated in item 1.2.3 above.
- .5 Broom Finishing:
 - .1 Apply a broom finishing to exterior concrete platforms, steps, and ramps, and elsewhere as indicated:
 - .2 Slightly roughen trafficked surface by brooming with fibre bristle broom perpendicular to main traffic route immediately after float finishing.
 - .3 Coordinate required final finishing with Consultant before application.
- .6 Moisture Reducing Finish:
 - .1 Prepare floor to ICRI CRP 3 or 4 as directed by manufacturer's written instructions
- .7 Liquid Applied Floor Hardener Finishing (Densification):
 - .1 Apply liquid floor densifier to surfaces in accordance with manufacturer's written instructions after initial floating.
 - .2 Cure concrete in accordance with manufacturer's recommended procedures.
- 3.2 Site Quality Control
 - .1 Testing and Measurements:
 - .1 Straightedge Measurement: Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 3050 mm long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed values indicated in item 1.2.3 above.
 - .2 CSA A23.1 has no measurement standard for unshored suspended slabs on steel structure; make straightedge measurements in accordance with CSA A23.1 with the following additional requirements:
 - .1 Layout measurement lines at 45° to the framing direction; to avoid taking measurements at points where anticipated deflections are similar.
 - .2 Offset measurement lines a minimum of 600 mm from column locations, and no portion of the measurement line shall fall within 600 mm of the boundary line, except where 25% of test section would be excluded from this measurement criteria.
 - .3 Measurement of F_L for suspended slab tolerances shall be within 80% of the values for slabs-on-grade.
 - .4 Measure and record elevation points at every 600 mm along length of test line.

- .2 Non-Conforming Work: Repair concrete floor slabs where they exceed the tolerances listed in this Section as follows:
 - .1 Floor Level Excess (High Spots): Grind and smooth surface areas that are higher than listed tolerances.
 - .2 Floor Level Deficiency (Bird Baths):
 - .1 Saw-cut perimeter of surface areas that are lower than listed tolerances to a minimum depth of 6 mm.
 - .2 Grind perimeter to a minimum of 6 mm to allow for flush flash patching.
 - .3 Roughen surface of flash patch area to a minimum ICRI CSP 5 – Medium Shotblast.
 - .4 Clean flash patch area and trowel in floor levelling mortar in accordance with manufacturers written instructions.
 - .5 Smooth and level surface of flash patch to match adjacent floor surfaces.
 - .3 Leave floors in ready for floor finishes supplied and installed by other sections.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide unit masonry assemblies in accordance with requirements of Contract Documents.

1.2 References

- .1 American Concrete Institute: (ACI):

.1 ACI 530/ACI 530.1, Building Code Requirements and Specification for Masonry Structures and Companion Commentaries

- .2 CSA Group (CSA):

- .1 CSA A165 CSA Standards on Concrete Masonry Units
- .2 CSA A179, Mortar and Grout for Unit Masonry
- .3 CSA A370, Connectors for Masonry
- .4 CAN/CSA A371, Masonry Construction for Buildings
- .5 CSA A3000, Cementitious Materials Compendium
- .6 CSA G30.18, Carbon steel bars for concrete reinforcement
- .7 CSA S304, Design of Masonry Structures (Includes Update No. 1)

- .3 ASTM International (ASTM):

- .1 ASTM A116, Standard Specification for Metallic-Coated, Steel-Woven Wire Fence Fabric
- .2 ASTM A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- .3 ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- .4 ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
- .5 ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength (withdrawn)
- .6 ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts
- .7 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- .8 ASTM A1064/A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- .9 ASTM C90, Standard Specification for Loadbearing Concrete Masonry Units
- .10 ASTM C207, Standard Specification for Hydrated Lime for Masonry Purposes
- .11 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- .12 ASTM C494/C494M, Standard Specification for Chemical Admixtures for Concrete
- .13 ASTM C744, Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units
- .14 ASTM D1056, Standard Specification for Flexible Cellular Materials; Sponge or Expanded Rubber

1.3 System Description

- .1 Interior Load and Deflection Criteria: Interior unit masonry walls are designed to withstand a lateral loading of 240 Pa (5 psf) positive and negative pressure, except where more stringent requirements are indicated.

1.4 Administrative Requirements

- .1 Pre-Construction Conference: Arrange a site meeting attended by the Contractor's superintendent, the Subcontractor's representative and foreman for this project, materials supplier(s), and other relevant personal before commencement of work for this Section; agenda for meeting will include; but not be limited to, the following:

- .1 Confirmation of specifications and details for the project

- .2 Required mortar, grout and concrete testing, batch control and grouting procedures
 - .3 Installation requirements of air/vapour membranes and insulation and coordination with other components of the Work
 - .4 Confirmation of cavity compartmentalization and drainage requirements
 - .5 Confirmation of reinforcement at corners and wall intersections
 - .6 Coordination of exterior crack control measures
 - .7 Confirmation of trowelled or tooled joints to concealed and exposed masonry faces
 - .8 Confirmation of methods for keeping mortar out of cavity space
 - .9 Confirmation of methods for controlling efflorescence during construction
 - .10 Confirmation of membranes and membrane flashing materials and details used for construction
 - .11 Review of submitted masonry unit samples
 - .12 Review of hot and cold weather requirements
- .2 Coordination: Coordinate components of the work of this Section with work performed by other Sections including; but not limited to, the following:
- .1 Steel Support Angles and Brackets:
 - .1 Coordinate requirements for structural steel support angles and brackets supplied and installed onto the building structure by Section 05 12 00 and Section 05 50 00.
 - .2 Provide requirements for supply of loose steel lintels and shelf angles installed by this section to Section 05 50 00.
 - .2 Masonry Anchors:
 - .1 Coordinate supply of anchor sections connecting to structural frame installed by Section 05 12 00.
 - .2 Include additional products for coordination furnished, but not installed, under this Section.
- 1.5 Submittals
- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
 - .1 Submit product data for each type of product specified.
 - .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings for the fabrication and installation of the Work. Prepare details at not less than 1:5 minimum scale. Include shop drawings for special shapes of masonry units, for details which are not shown on the Consultant's drawings, and for details which vary from the Contract Documents.
 - .3 Certifications: Submit for Consultant's action:
 - .1 Certificates: Submit statements of material properties indicating compliance with specified requirements for each type and size of the following:
 - .1 Masonry Units:
 - Include material test reports substantiating compliance with requirements.
 - Include size variation data verifying that actual range of sizes falls within specified tolerances for bricks.
 - Include material test report for efflorescence in accordance with CSA A82, modified for concrete brick and concrete masonry units.
 - Include confirmation that materials used in the manufacture of concrete masonry units have a lowered potential for the formation of efflorescence.
 - .2 Cementitious Materials:
 - Include brand, type, and name of manufacturer for site mixed mortar materials.
 - Include description of type and proportions of ingredients for pre-blended, dry mortar mixes.
 - Include description of type and proportions of ingredients for grout mixes.

- .3 Accessories:
- Reinforcing bars
 - Joint reinforcement
 - Anchors, ties, and metal accessories
- .4 Source Quality Control Submissions: Submit mix designs for each type of mortar and grout including descriptions of type and proportions of ingredients as follows:
- .1 Include test reports for mortar mixes required in accordance with proportion specification in accordance with CSA A179.
 - .2 Include test reports for grout mixes required in accordance with compressive strength requirement in accordance with CSA A179.
 - .3 Include confirmation that mortar materials used have a lowered potential for development of efflorescence in accordance with modified testing for CSA A82.
 - .4 Submit mix designs for concrete in accordance with Section 03 31 00 and Structural Concrete mix design.
- .5 Site Quality Control Submissions: Submit detailed description of methods, materials, and equipment used in accordance with cold or hot weather requirements; and proposed unit masonry cleaning techniques.
- 1.6 Quality Assurance
- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
 - .2 Fire Resistance Ratings: Provide each fire rated condition in the Work with materials and construction determined to be a fire resistant system in accordance with CSA A165.1 fire endurance testing conducted by ULC or by other qualified testing agency acceptable to the authorities having jurisdiction.
 - .3 Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of national, provincial and municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.
 - .1 Requirements for fire-rated or lateral support conditions are not necessarily fully defined on the Drawings; comply with applicable regulations.
- 1.7 Delivery, Storage and Handling
- .1 Delivery and Acceptance Requirements: Deliver pre-blended, dry mortar mix in moisture resistant containers designed for lifting and emptying into dispensing silo; store dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
 - .2 Storage and Handling Requirements: Store masonry units on elevated platforms in a dry location and as follows:
 - .1 Stack materials on floors of building so that structural design loads are not exceeded; coordinate with Consultant.
 - .2 Cover tops and sides of stacks with waterproof sheeting securely tied to pallets if units are not stored in an enclosed location; do not install masonry units that become wet until they are dry.
 - .3 Store cementitious materials on elevated platforms, under cover, and in a dry location; do not use cementitious materials that have become wet or damp.
 - .4 Store aggregates where grading and other required characteristics can be maintained; store to prevent contamination by substances deleterious to performance and appearance.
 - .5 Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

- 1.8 Site Conditions
- .1 Protection of Masonry: Protect masonry and other work from marking and other damage and as follows:
- .1 Cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work during construction until permanent flashings and membranes are completed.
 - .2 Cover partially completed masonry when construction is not in progress to prevent wetting of inside wythes of construction and contribution to efflorescence.
 - .3 Extend cover a minimum of 600 mm down both sides and hold cover securely in place.
 - .4 Secure cover a minimum of 600 mm down face next to un-constructed wythe and hold cover in place where 1 wythe of multi-wythe masonry walls is completed in advance of other wythes.
 - .5 Provide adequate bracing for masonry during construction and until permanent lateral supports are in place.
 - .6 Do not apply uniform floor or roof loads for a minimum of 12 hours and concentrated loads for a minimum of 3 days after building masonry walls or columns.
- .2 Stain Prevention:
- .1 Use non-staining coverings.
 - .2 Protect completed work from mortar droppings.
 - .3 Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted; immediately remove grout, mortar, and soil that come in contact with such masonry.
 - .4 Protect base of walls from rain splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - .5 Protect sills, ledges, and projections from mortar droppings.
 - .6 Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - .7 Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
 - .8 Protect adjacent surfaces and Work from damage during cleaning of masonry.
- .3 Cold Weather Requirements:
- .1 Do not use frozen materials or materials mixed or coated with ice or frost.
 - .2 Do not build on frozen substrates.
 - .3 Remove and replace unit masonry damaged by frost or by freezing conditions.
 - .4 Comply with cold weather construction requirements contained in reviewed submittals and as follows:
 - .1 Keep materials from freezing and free from ice when air temperature has dropped below 0°C.
 - .2 Build masonry in heated enclosures heated using smokeless enclosed flame heaters when temperature remains below 0°C.
 - .3 Keep materials above 5°C during installation and until batch is used.
 - .4 Prevent Work from freezing for a minimum of 48 hours by heated enclosure.
 - .5 Protect masonry from frost heave and other forces to which it would normally not be subject after completion of the Work.
 - .5 Cold Weather Cleaning:
 - .1 Use liquid cleaning methods only when air temperature is 4°C and above and will remain so until masonry has dried, but a minimum of 7 days after completing cleaning.
 - .2 Do not clean unit masonry when wet weather conditions prevent rapid drying of cleaned surfaces.

2. PRODUCTS

2.1 Concrete Masonry Units

.1 Standard Concrete Masonry Units: Manufactured in accordance with CAN/CSA A165.1, and as follows:

- .1 Classification: H/15/D/O.
- .2 Size: Modular metric to sizes indicated on Drawings.
- .3 Special shapes:
 - .1 Provide bull nosed units for exposed corners.
 - .2 Provide purpose made shapes for lintels and bond beams.
 - .3 Provide additional special shapes required for project.

.2 Fire Resistant Concrete Masonry Units: Manufactured in accordance with CAN/CSA A165.1 as modified below:

- .1 Classification: H/15/D/O except as modified by fire resistance requirements specified below.
- .2 Concrete Composition: Type L₂30S Concrete.
- .3 Fire Resistant Characteristics: Aggregate Type and Equivalent Thickness as required to provide fire resistance indicated, determined in accordance with Appendix D of the National Building Code, subsections D-1.4 and D-1.6.
- .4 Fire Rating: as indicated on Wall Assembly Types listed on Drawings.
- .5 Size: Modular metric to sizes indicated on Drawings.
- .6 Special shapes: Manufactured to same composition as listed above and as follows:
 - .1 Provide bull nosed units for exposed corners.
 - .2 Provide purpose made shapes for lintels and bond beams

2.2 Masonry Concrete Lintels

.1 Masonry Lintels:

- .1 Prefabricated or built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed and filled with concrete, refer to on Drawings.
- .2 Cure precast lintels before handling and installing.
- .3 Temporarily support built-in-place lintels until cured.

.2 Concrete Lintels:

- .1 Formed-in-place, reinforced concrete lintels in accordance Structural Drawings.

2.3 Mortar and Grout Materials

.1 Cementitious Materials: In accordance with CSA A179, and as follows:

- .1 Cement Type: Normal Portland Cement in accordance with CSA A3000, Type GU
- .2 Masonry Cement: In accordance with CSA A3000
- .3 Quick Lime: In accordance with CSA A3000
- .4 Hydrated Lime: In accordance with ASTM C207; Type S or SA

.2 Aggregates: In accordance with CSA A179, and as follows:

- .1 Mortar Aggregates:
 - .1 Use same brands of materials and source of aggregate for entire project.
 - .2 Use washed aggregate consisting of natural sand or crushed stone for mortar that is exposed to view.
 - .3 Use aggregate graded with 100% passing the No. 16 (1.18-mm) sieve for joints less than 6 mm thick.
 - .4 White Mortar Aggregates: Natural white sand or crushed white stone.
 - .5 Coloured Mortar Aggregates: Natural sand or crushed stone of colour necessary to produce required mortar colour.

- .2 Grout Aggregates: In accordance with CSA A179.
- .3 Cold Weather Admixture:
 - .1 Non-chloride, non-corrosive, accelerating admixture in accordance with CSA A179 and ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 - .2 Acceptable Materials:
 - .1 Grace Construction Products, Morset
 - .2 Degussa ChemRex, Trimix-NCA
- .4 Water: Potable in accordance with CSA A179.
- .5 Grout: In accordance with CSA A179, Table 3.
- 2.4 Galvanizing
 - .1 The following galvanizing requirements apply to steel anchors, ties, reinforcing and accessories where requirements are not otherwise specifically listed:
 - .1 Ties and Reinforcing:
 - .1 Mill Galvanized (Interior Use): In accordance with ASTM A116, Class 3.
 - .2 Hot Dip Hardware and Bolts: In accordance with ASTM A153, Class B-2 regardless of location.
 - .3 Hot Dip Sheet Steel: In accordance with ASTM A653, Coating Designation Z600, regardless of location.
 - .4 Structural Shapes and Pipes: In accordance with ASTM A123, Grade 85, regardless of location.
- 2.5 Reinforcement
 - .1 Reinforcing Bars: Deformed bars, all Grade 400 W, in accordance with CSA A371 and CSA G30.18.
 - .2 Masonry Joint Reinforcement: In accordance with to CSA A371 and ASTM A1064/A1064M, with corrosion protection in accordance with CSA S304 and CSA A370, and as follows:
 - .1 Interior Walls: Mill galvanized, carbon steel.
 - .2 Exterior Walls: Hot dip galvanized, carbon steel.
 - .3 Wire Size for Side Rods: W1.7 or 3.8 mm diameter.
 - .4 Wire Size for Cross Rods: W1.7 or 3.8 mm diameter.
 - .5 Spacing of Cross Rods, Tabs, and Cross Ties: At a maximum of 400 mm \varnothing /c.
 - .6 Lengths: A minimum of 3000 mm with prefabricated corner and tee units.
 - .3 Connectors: In accordance with to CSA A370 and CSA S304 with hot dip and mill galvanized finish.
 - .4 Single Wythe Masonry Joint Reinforcement: Ladder type with single pair of side rods.
- 2.6 Ties and Anchors
 - .1 Ties and anchors specified in this section shall be designed in accordance with CSA A370 for non-conventional masonry connectors as follows:
 - .1 Deflection: Maximum 2 mm, including free play, when acted upon by a lateral load of 0.45 kN, in all possible positions of adjustment.
 - .2 Positive restraint at position of maximum adjustment.
 - .3 Free play of multi-component ties maximum 1.2 mm when assembled in all possible configurations.
 - .4 Anchors shall allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall.

- .2 Lateral Partition Supports (Top of Wall Anchors):
 - .1 Angle Support: Fabricated from 2.657 mm core metal thickness angled steel plate having 75 mm long legs fastened to deck structure to allow vertical movement of masonry assembly; mill galvanized; coordinate with Section 07 84 00 for firestopping insulation and smoke seals.
 - .2 Plate Support: Fabricated from 2.657 mm core metal thickness steel plate with 10 mm diameter metal 150 mm long welded to plate having closed end plastic tube fitted over rod that allows rod to move in and out of tube; hot dip galvanized after fabrication.
 - .3 Rigid T-Intersection Anchors: Fabricate from steel bars 38 mm wide x 6 mm thick x 600 mm long with ends turned up 50 mm or with cross pins at installers option; hot dip galvanized.
 - .4 Anchor Bolts: Headed or L-shaped steel bolts in accordance with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers; hot-dip galvanized in accordance with ASTM A153, Class C.
 - .5 Toggle Bolts: Tumble wing type, class and style as required for supported construction.
- 2.7 Miscellaneous Masonry Accessories
- .1 Firestopping: As specified under Section 07 84 00.
 - .2 Sealants: As specified under Section 07 92 00, and as follows:
 - .1 Vertical Sealant: Colour to match brick
 - .2 Horizontal Sealant: Colour to match mortar
 - .3 Maintenance Cleaners: Manufacturer's recommended maintenance cleaners formulated for use with anti-graffiti coating used on project.
 - .4 Joint Filler:
 - .1 Compressible Filler: Pre-moulded filler strips in accordance with ASTM D1056, Grade 2A1; compressible up to 35%; of width and thickness indicated; formulated from neoprene.
 - .5 Bond Breaker Strips: #15 asphalt saturated, organic roofing felt in accordance with CSA A123.3.
 - .6 Reinforcing Bar Positioners:
 - .1 Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in centre of cells.
 - .2 Fabricate wire units are formed from 3.6 mm diameter steel wire, hot-dip galvanized after fabrication.
 - .3 Provide units with either two loops or four loops as needed for number of bars indicated in Lintel Schedule on Drawing
 - .4 Acceptable Materials:
 - .1 Dayton Superior Corporation, Dur-O-Wal D/A 810, D/A 812 or D/A 817
 - .2 Heckmann Building Products Inc., No. 376 Rebar Positioner
 - .3 Hohmann and Barnard, Inc., #RB or #RB-Twin Rebar Positioner
- 2.8 Masonry Cleaners
- .1 Proprietary Cleaner: Masonry manufacturer's recommended cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discolouring or damaging masonry surfaces:
 - .1 Use product expressly approved by manufacturer for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned, and as accepted by the Consultant.

- .2 Verify acceptability of cleaner for cleaning masonry with pigmented mortar joints and for kinds of masonry units specified.
- .3 Acceptable Materials: Subject to compliance with requirements, products that may be used to clean unit masonry surfaces include, but are not limited to, the following:
 - .1 Cleaners for Light Coloured Unit Masonry Not Subject to Metallic Staining with Mortar Not Subject to Bleaching:
 - Diedrich Technologies, Inc., 202 New Masonry Detergent
 - Fabrikem Type L
 - ProSoCo, Inc., Sure Klean No. 600 Detergent

2.9 Mortar and Grout Mixes

- .1 Do not use admixtures, including pigments, air entraining agents, accelerators, retarders, water repellent agents, antifreeze compounds, or other admixtures; unless approved in writing by the Consultant, and as follows:
 - .1 Do not use calcium chloride in mortar or grout.
 - .2 Limit cementitious materials in mortar to portland cement, mortar cement, and lime.
 - .3 Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement, mortar cement, and lime.
 - .4 Add cold weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar colour is consistent.
- .2 Mortar and Concrete for Unit Masonry Trowel Ready (Wet Pre-Mix):
 - .1 Batch and mix materials in accordance with CSA A179 Property Specification, at an acceptable batch plant; use hand mixing only if accepted in writing by the Consultant.
 - .2 Provide the following types of mortar for applications stated unless another type is specifically indicated on Drawings or needed to provide required compressive strength of masonry:
 - .1 Mortar for Interior Masonry, and as follows:
 - Loadbearing: Type N.
 - Non-loadbearing: Type O.
- .3 Grout for Unit Masonry: Mix materials in accordance with CSA A179, and as follows:
 - .1 Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) in accordance with recommendations contained in ACI 530/530.1 for dimensions of grout spaces and pour height.
 - .2 Provide grout with a slump of 200 mm to 280 mm.

3. EXECUTION

3.1 Installation

- .1 Thickness: Build cavity, composite walls and other masonry construction to full thickness shown on Drawings; build single wythe walls to actual widths of masonry units, using units of widths indicated on Drawings.
- .2 Build chases and recesses to accommodate items specified in this and other Sections; leave openings for equipment to be installed before completing masonry; complete masonry to match the construction immediately adjacent to opening after installing equipment.
- .3 Use full size units without cutting except as follows:
 - .1 Cut units with motor driven saws if cutting is required to provide a continuous pattern or to fit adjoining construction
 - .2 Provide clean, sharp, un-chipped edges.
 - .3 Allow units to dry before laying unless wetting of units is specified.

- .4 Install cut units with cut surfaces and cut edges concealed where possible; obtain Consultant's acceptance where cut edges must be exposed.
 - .4 Select and arrange units for exposed unit masonry to produce a uniform blend of colours and textures; mix units by drawing units diagonally down multiple rows from at least three different pallets as masonry units are placed.
 - .5 Installation Tolerances: Install masonry to tolerances listed in CSA A371.
- 3.2 Laying Masonry Walls
- .1 Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement type joints, returns, and offsets; avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
 - .2 Bond Pattern for Exposed Masonry: Lay exposed masonry in running bond pattern indicated on Drawings; do not use units with less than 100 mm horizontal face dimensions at corners or jambs; lay masonry in running bond where not otherwise indicated. Bond pattern and joint profiles as detailed on Drawings.
 - .3 Lay concealed masonry with all units in a wythe in running bond or bonded by lapping a minimum of 100 mm, and as follows:
 - .1 Bond and interlock each course of each wythe at corners.
 - .2 Do not use units with less than nominal 100 mm horizontal face dimensions at corners or jambs.
 - .4 Stopping and Resuming Work:
 - .1 Stop work by racking back units in each course from those in course below; do not tooth.
 - .2 Clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry when resuming work.
 - .5 Built-In Work:
 - .1 Build in items specified in this and other Sections as construction progresses.
 - .2 Fill in solidly with masonry around built-in items.
 - .3 Fill space between steel frames and masonry flexible perimeter joint filler.
 - .4 Place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core where built-in items are to be embedded in cores of hollow masonry units.
 - .5 Protect built-in items from damage arising from work of this Section.
 - .6 Grouting and Concrete Core Fills:
 - .1 Fill cores in hollow concrete masonry units with concrete 600 mm under bearing plates, beams, lintels, posts, and similar items.
 - .2 Use concrete where indicated, and also for vertical core filling, lintel beams, bond beams and other filled cores where reinforcing steel is indicated.
 - .3 Use fine grout where the space being grouted is 50 mm or less in its least dimensions; use concrete in all other applications that call for grout.
 - .4 Use square end concrete masonry units wherever a full or half concrete masonry unit will receive concrete fill.
 - .5 Use full mortar bedding of cross webs for cores that are filled.
 - .6 Fill cores in lifts of 1200 mm maximum; provide cleanout openings for lifts in excess of 1200 mm where Consultant has accepted larger lifts.
 - .7 Consolidate core fill during placement by vibration or puddling.
 - .8 Stop concrete core fill 38 mm below top surface of lift when ever filling will be stopped for more than a 1 hour time duration.
 - .9 Fill all cores of roof parapets with concrete.

- .10 Secure vertical reinforcement in position at top and bottom of core, and a maximum 1200 mm spacing, refer to Drawings for location of vertical reinforcement.
- .11 Fill voids solid with mortar so that ties and anchors are set in full mortar bed where masonry walls abut steel or concrete columns.
- .7 Build non-load bearing interior partitions full height of storey to underside of solid floor or roof structure above, leaving a gap to allow for structural deflection, and as follows:
 - .1 Install compressible filler in joint between top of partition and underside of structure above; coordinate fill requirements for fire rated assemblies with Section 07 84 00.
 - .2 Fasten lateral partition supports to structure above and build into top of partition; grout cells of concrete masonry units solidly around plastic tubes of anchors and push tubes down into grout to provide 13 mm clearance between end of anchor rod and end of tube; space anchors at 1200 mm O/c.
- 3.3 Mortar Bedding and Jointing
 - .1 Lay hollow brick and concrete masonry units as follows:
 - .1 Face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - .2 Webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 - .3 Webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - .4 Entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
 - .2 Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place; do not deeply furrow bed joints or slush head joints.
 - .3 Tool exposed joints when mortar is thumbprint hard, using a profiled jointer tool, and as follows:
 - .1 Interior: raked profile.
 - .2 Exterior: Concave profile: all exposed horizontal joints.
- 3.4 Masonry Joint Reinforcement
 - .1 Install entire length of longitudinal side rods in mortar with a minimum cover of 16 mm on exterior side of walls and 13 mm in other locations.
 - .2 Lap reinforcement a minimum of 150 mm, and as follows:
 - .1 Space reinforcement at a maximum of 600 mm O/c.
 - .2 Space reinforcement at a maximum of 200 mm O/c in parapet walls
 - .3 Install reinforcement at a maximum of 200 mm above and below wall openings and extending 300 mm beyond openings.
 - .3 Interrupt joint reinforcement at control and expansion joints.
 - .4 Provide continuity at wall intersections by using prefabricated T-shaped units.
 - .5 Provide continuity at corners by using prefabricated L-shaped units.
- 3.5 Anchoring Masonry To Structural Members
 - .1 Anchor masonry to structural members where masonry abuts or faces structural members as follows:
 - .1 Provide a minimum of 13 mm wide open space between masonry and structural member
 - .2 Keep open space free of mortar and other rigid materials.
 - .3 Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
 - .4 Space anchors at a maximum of 600 mm vertically on-centre and 900 mm horizontally on-centre.

3.6 Control and Expansion Joints

- .1 Install control and expansion joint materials in unit masonry as masonry progresses; do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- .2 Form control joints in concrete masonry consisting of a complete vertical break free from mortar using one of the following methods:
 - .1 Install preformed control joint gaskets designed to fit standard sash block.
 - .2 Install interlocking units designed for control joints; install bond breaker strips at joint; keep head joints free and clear of mortar or rake out joint for application of sealant.
 - .3 Refer to Drawings for control and expansion joint locations, and vertical reinforcing requirements; confirm location with Consultant before installation; confirm with Consultant where not shown on Drawings.
- .3 Form expansion joints in brick masonry consisting of a complete vertical break free from mortar using one of the following methods:
 - .1 Form open joint full depth of brick wythe a minimum of 10 mm for installation of sealant and backer rod specified in accordance with Section 07 92 00.
 - .2 Locate joints at 6000 mm O/c maximum and at a minimum of 3600 mm from any corners, any other indication notwithstanding.
 - .3 Refer to Drawings for control and expansion joint locations, and vertical reinforcing requirements; confirm location with Consultant before installation; confirm with Consultant where not shown on Drawings.
- .4 Install a minimum 10 mm high horizontal, pressure relieving joints by either leaving an air space or inserting a compressible filler, sealant and backer rod specified in Section 07 92 00; locate horizontal, pressure relieving joints beneath shelf angles supporting masonry.

3.7 Lintels

- .1 Install steel lintels where required; coordinate with Section 05 50 00 for sizes and spans.
- .2 Provide minimum 200 mm bearing at each jamb.

3.8 Concrete Masonry Lintels and Bond Beams

- .1 Install reinforced concrete masonry unit lintels over openings in masonry where steel or reinforced concrete lintels are not indicated, and as follows:
 - .1 Provide double course continuous concrete filled bond beams where indicated on Structural Drawings; confirm all lintel reinforcement over 1200 mm span with Consultant prior to installation where not specifically shown.
 - .2 Provide single course concrete filled bond beams above and below all openings 200 mm to 600 mm wide; reinforce with one 15M bar; end bearing not less than 200 mm.
- .2 Form concrete filled bond beams with special bond beam units that have the top half of the cross webs removed and allow continuity of vertical reinforcement.
- .3 Form two course concrete masonry unit lintels using lintel units 200 mm long and 400 mm high; form the top course of three course concrete masonry unit lintels with a bond beam block flipped upside down so the cross webs are at the top.
- .4 Cut and form each end so that the lintel ends with a vertical joint in line with each jamb.
- .5 Cut away webs of each side wall of concrete masonry units as necessary to obtain bearing at lintels ends; extend the reinforcement and concrete into cores.
- .6 Provide 400 mm minimum lintel bearing for spans to 2000 mm, and 600 mm for greater spans, where not otherwise detailed. Support lintels rigidly during construction.

3.9 Reinforced Unit Masonry Installation

.1 Temporary Formwork and Shores:

- .1 Construct formwork and shores as needed to support reinforced masonry elements during construction.
- .2 Construct formwork to provide shape, line, and dimensions of completed masonry as indicated.
- .3 Make forms sufficiently tight to prevent leakage of mortar and grout.
- .4 Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
- .5 Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

.2 Place reinforcement in accordance with CSA A371.

.3 Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

.4 Comply with requirements stated in CSA A371 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

.5 Limit height of vertical grout pours to a maximum of 1500 mm.

3.10 Ties to the Structure

.1 Install welded anchors with adjustable wire ties, at 400 mm O/c; vertically for columns, horizontally for beams, where masonry walls abut or pass steel structural members.

.2 Fill masonry unit solidly with grout or Type S mortar where an anchor crosses a void or passes into the cell of a hollow unit.

.3 Tie unit masonry walls and partitions to concrete columns and beams; fill end space and first block core with concrete and reinforce.

.4 Ties to the structure:

.1 Tie walls to undersides of structure by placing continuous 2.657 mm metal angles on both sides of the wall, secured to the structure above only, to provide lateral restraint without limiting vertical movement.

.2 Secure lateral support angles at 400 mm maximum centres and within 100 mm of each end.

.3 Connect lateral support angles for a factored load of 5 kN/m applied at the tip of the vertical leg

.4 Mount anchor heads flush.

3.11 Chemical Anchors

.1 Coordinate work with Contractor for work that forms a part of this Section.

.2 Install anchors in accordance with manufacturer's written instructions, and as follows:

.1 Drill and clean anchor holes in accordance with manufacturer's instructions; insert screen tube, prepare and mix two part adhesive anchor system and fill holes; insert connector pins and twist to ensure that adhesive is in contact with connector pin.

.2 Do not adjust connector pins until after gel time of adhesive occurs.

- .3 Testing:
 - .1 Test first 10 anchors to demonstrate a pullout capacity equal to four times the required service capacity of 0.44 kN after cure time established by adhesive manufacturer.
 - .2 Randomly test 2% of remaining installed anchors after cure time established by adhesive manufacturer to service load capacity of 0.44 kN; additional tests may be required where failures occur.

- 3.12 Repairing, Pointing and Cleaning
 - .1 Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units; install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
 - .2 Pointing:
 - .1 Enlarge voids and holes, except weep holes, and completely fill with mortar during the tooling of joints.
 - .2 Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance.
 - .3 Prepare joints for sealant application, where applicable.
 - .3 Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
 - .4 After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - .1 Remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels.
 - .2 Brush efflorescence off of surfaces using a stiff bristled brush to the greatest extent possible.
 - .3 Do not attempt any wet cleaning methods unless Meteorological Service of Canada weather forecast indicates drying conditions and temperatures greater than 7°C for a minimum of three (3) days after cleaning of masonry surfaces:
 - .1 Local weather forecast and trends can be viewed at <http://www.weatheroffice.ec.gc.ca/>.
 - .2 Wet cleaning can cause additional efflorescence bloom if not allowed to dry sufficiently.
 - .4 Attempt cleaning with plain water and stiff bristled brushes before proceeding to chemical or acidic cleaning methods.
 - .5 Test cleaning methods on sample wall panel; leave one-half of panel un-cleaned for comparison purposes.
 - .6 Obtain Consultant's approval of sample cleaning before proceeding with cleaning of masonry.
 - .7 Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - .8 Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - .9 Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20 and 23.
 - .10 Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A and 8-3A applicable to type of stain on exposed surfaces.
 - .11 Clean masonry with a proprietary acidic cleaner applied in accordance with manufacturer's written instructions only when other cleaning methods have not succeeded.

3.13 Masonry Waste Disposal

.1 Salvageable Materials:

- .1 Excess masonry materials remain the property of the installing Subcontractor.
- .2 At completion of unit masonry work, remove from Project site.

END OF SECTION

1 General

1.1 INTENT

- .1 This section is included for the information of the Contractor to coordinate their activities with the inspection and testing agency retained by the Owner.
- .2 The Owner is responsible for establishing the Quality Assurance (QA) program and the Contractor is responsible for implementing and maintaining the design, fabrication and erection related Quality Control (QC) functions and procedures.
- .3 Steel testing and inspection is part of the QA program to be performed by one or more qualified independent inspection and testing agencies retained and paid for by the Owner.
- .4 The Contractor shall include costs for coordination with the Owner's appointed inspection and testing agencies only; do not include any costs for QA inspection and testing. Costs for QC functions and procedures are the responsibility of the Contractor.
- .5 Inspection and testing carried out by the Owner's inspection and testing agency is intended to confirm that the Contractors and Steel Sub-Contractor's QC and QA procedures are functioning effectively:
 - .1 The Contractor and Steel Sub-Contractors' own QC and QA procedures shall be capable of confirming that the Work is performed in accordance with the Contract Documents.
 - .2 The Owner's inspection and testing is not intended to serve as any part of the Contractor and Steel Sub-Contractor's QC and QA.
 - .3 The purpose of the steel testing and inspection program is to inspect, sample, and test a sufficient number of members, details and procedures, and a sufficient quantity of material, in order to determine if the structural work is proceeding in general accordance with the Contract requirements.
 - .4 The Contractor and Steel Sub-Contractor shall cooperate fully with the Owner's testing agencies by allowing free access to all parts of the work for the purpose of testing and review at all times. Prior to the commencement of work, the schedule of shop fabrication and field construction shall be provided to the testing agency. The Contractor / Steel Sub-Contractor shall notify the Owner's testing agency when work is ready for review.
 - .5 The testing agency is responsible to the Owner and has the authority to, and is expected to reject any work not meeting the Contract requirements.
- .6 Terms of reference for the inspection and testing services for structural steel and steel deck include, but are not limited to, the following:
 - .1 The inspection and testing agency is responsible for review of the work performed by the Contractor, Steel Sub-Contractor and reporting to the Owner that the work is in compliance with the applicable References and Contract Documents.
 - .2 The inspection and testing agency shall not take any instructions from the Contractor or Steel Sub-Contractor.

- .3 The responsibility for quality of construction and compliance with Contract Documents rests solely with the Contractor. Inspection and testing by the Owner shall not be deemed to relieve the Contractor of any of his/her obligations.
- .4 The Consultant will make all engineering decisions with respect to rejection criteria and rework required and inform the Owner.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 Section 05 12 23 – Structural Steel for Buildings
- .2 Section 05 31 00 – Steel Decking
- .3 Section 05 50 00 – Metal Fabrications

1.3 DEFINITIONS

- .1 Quality Management Plan: Quality Management Plan performed by the Steel Sub-Contractor capable of confirming that the work of steel fabrication and erection is conducted in accordance with the Contract Documents. The Owner's Site and Source Quality Assurance requirements in this section do not replace or eliminate the requirement of the Contractor to perform their own Quality Management Plan.
- .2 Site Quality Assurance: Inspections and testing performed during the installation of components and that is further defined as site assembled or installed work occurring as a part of execution; work that is not performed in the shop or off site.
- .3 Source Quality Assurance: Inspections and testing performed during fabrication of components and that is further defined as shop assembled or manufactured products; work that is not performed on site.
- .4 Testing Agency: Shall mean the inspection and testing agency responsible to the Owner.
- .5 Non-destructive Testing: Shall mean magnetic particle, ultrasonic or radiographic testing as determined appropriate by the Testing Agency.

1.4 REFERENCE DOCUMENTS

- .1 Canadian Standards Association (CSA):
 - .1 CSA S16-19 Design of Steel Structures
 - .2 CSA G40.20-13 General Requirements for Rolled or Welded Structural Quality Steel (R2023)
 - .3 CSA G40.21-13 Structural Quality Steel (R2023)
 - .4 CSA W47.1-19 Certification of Companies for Fusion Welding of Steel
 - .5 CSA W55.3-08 Certification of Companies for Resistance Welding of Steel and Aluminum (R2023)
 - .6 CSA W59-13 Welded Steel Construction (Metal Arc Welding) (R2023)
 - .7 CSA W178.1-14 Certification of Welding Inspection Organizations (R2023)
 - .8 CSA W178.2-14 Certification of Welding Inspectors (R2023)
- .2 Canadian Welding Bureau (CWB Group Industry Services):

- .1 CWB 113E/07-1 Weld Quality & Examination Methods Study Guide
- .3 Canadian Sheet Steel Building Institute (CSSBI):
 - .1 CSSBI 10M-18 Standard for Steel Roof Deck
 - .2 CSSBI 12M-17 Standard for Composite Steel Deck
- .4 Other Applicable References:
 - .1 National Building Code of Canada 2020
 - .2 Reviewed Shop Drawings for the project

1.5 QUALITY ASSURANCE

- .1 The Quality Assurance requirements listed in this Section are specific to the Owner's inspection and testing agency; refer to technical specification sections for Contractor's quality assurance requirements.
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Testing Agency: Inspection and testing agency shall be experienced in all aspects of the required work as described in this Section; and shall be independent from the Consultant, structural steel Contractor, open web steel joist Contractor, steel deck Contractor, and the supplier of post-installed fastening systems.
 - .2 Testing and Inspection Personnel: Use personnel that have completed work of a similar scope and complexity to that required for this Project.
- .3 Certification: Provide proof of the following during the course of the Work:
 - .1 Agency Welding Certificates: Provide proof indicating that inspection and testing agency is certified CSA W178.1 for welding inspection Building Category.
 - .2 Personnel Welding Certificates: Provide proof indicating that personnel examining welds and that are employed by the inspection and testing agency are Canadian Welding Bureau (CWB) certified Welding Inspectors or a person with equivalent qualifications.

1.6 ADMINISTRATION REQUIREMENTS

- .1 Review work of Quality Control: notify Consultant of non-compliant workmanship or materials within one (1) day of discovery.
- .2 Invoicing - Prepare detailed monthly invoices addressed to the Owner and submit to the Consultant for review.

2 Products

2.1 REPORTS: GENERAL

- .1 Provide required information in accordance with Submittal Procedures and General Requirements.

- .1 Inspection Reports: Submit a report of each inspection detailing the following for each review:
 - .1 Name and Certificate Number of welders involved.
 - .2 Copy of welding procedure for all welds not pre-qualified by CSA W59
 - .3 Identification mark of members reviewed and compliance status.
- .2 Final Report: Submit a final report summarizing all previous reports and specifically stating a belief as to the compliance of the work, signed by the testing agency's certified inspector responsible for the testing and inspection program. Certify all welds and connections and include confirmation that required repairs have been completed. The final report shall be submitted under the seal and signature of a Professional Engineer registered in the Yukon. Send copies of the final report to the following:
 - .1 Owner
 - .2 Consultant
 - .3 General Contractor
 - .4 Structural Steel Trade Contractor

3 Execution

3.1 TESTING: GENERAL

- .1 Inspection and Testing Agency Coordination: Inspection and testing agency is required to coordinate with the Contractor for notification requirements regarding the timing of testing and inspections, and as follows:
 - .1 Coordinate inspection and testing activities with Contractor; be aware of current work schedule and bring to the attention of the Consultant any testing or inspection requirement apparently being overlooked.
 - .2 Coordinate a common marking protocol for all parts or joints that have been reviewed and accepted.
 - .3 Coordinate work of this Section with Section 01 00 10 – General Requirements; notify Consultant of non-compliant workmanship or materials within one (1) day of discovery.
- .2 Where stated in this Section, the frequency of inspection or testing is the initial frequency with which the testing and inspection agency shall perform their activities. As the Contractor's own QA and QC program demonstrates its effectiveness during the course of the project, the frequency of testing and inspection by the Owner's inspection and testing agency may be adjusted in consultation with the Owner, Contractor, and the Consultant:
 - .1 Immediately inform the Consultant when sufficient number of shop or site visits are not clearly identified and make a recommendation for additional shop or site visits to form an opinion as to the compliance of the work.
 - .2 Immediately inform the Consultant when fabrication and erection conditions are such that a reduced program of testing and inspection is deemed appropriate or an increased program of testing and inspection is deemed necessary to form an opinion as to the compliance of the work.
- .3 Additional tests may be directed by the Consultant, or requested by the Contractor:
 - .1 Costs of tests requested by the Consultant will be paid by the Owner.
 - .2 Costs of tests requested by the Contractor will be paid by the Contractor.

- .4 Where the frequency of inspection and testing is not specifically stated in this Section, the Owner's inspection and testing agency shall make a recommendation to the Consultant.
- .5 Identify with a distinguishing mark all parts or joints that have been reviewed and accepted.

3.2 SOURCE QUALITY ASSURANCE

- .1 Structural Steel:
 - .1 Review correlated mill test certificates for compliance with specified material.
 - .2 Review structural steel and confirm that steel is supplied by an acceptable source in accordance with the requirements of the Contract Documents; confirm that source of steel sections is clearly identified with raised lettering embossed on at least one face of the steel sections.
 - .3 Randomly check and record member dimensions, thicknesses, lengths and fabrication details for tolerance; +/- 10% of columns, and +/- 5% total of beams and girders.
 - .4 Check milling of columns and base plates.
 - .5 Examine coatings and application to verify compliance.
 - .6 Visually examine designated members for compliance with requirements of Architecturally Exposed Steel.
 - .7 Random examination of loading to ensure proper handling and shipping.
- .2 Welding:
 - .1 Review shop welding procedures and welders' qualification certificates for the processes required.
 - .2 Perform a visual review of all types of welds for size, length and workmanship.
 - .3 Perform magnetic particle inspection of randomly selected welds (5 to 10% of connections).
 - .4 Perform ultrasonic examination of 100% of complete penetration welds subject to tension and of 10% of those subject to compression.
 - .5 Perform a visual review of all types of welds and workmanship of embedded plates.
 - .6 Perform ultrasonic examination of splices of truss chord members; 100% of tension splices and 10% of compression splices.
- .3 Headed Shear Connectors:
 - .1 Review supplier, grade, diameter, length, and head geometry for compliance.
 - .2 Perform 100% visual review of connector welds.
 - .3 Perform Bend tests in accordance with CSA W59 if visual review indicates less than full 360-degree flash and hammer strike makes a dull sound indicating incomplete fusion.
- .4 Reports: Report the following for each review of shop fabricated work:
 - .1 Name and Certificate Number of welders involved.
 - .2 Identification mark of members reviewed and compliance status.

3.3 SITE QUALITY ASSURANCE

- .1 Structural Steel Framing:
 - .1 Review structural steel Erector's welding procedures and welders' qualification certificates for the procedures required.
 - .2 Examine steel for shipping and handling damage.
 - .3 Randomly examine erected work for fit-up, dimensions, tolerances, alignment and plumbness; include checking by instrument a minimum of 10% of beams and 10% of columns in the building for plumbness, alignment, and tolerance.
 - .4 Review temporary bracing and stability of the steel frame during erection.
 - .5 Confirm that all isolations between hot-rolled and stainless steel are installed correctly and function properly.
 - .6 Perform the following inspections:
 - .1 100% visual examination of site welds for size, length and workmanship.
 - .2 Magnetic particle inspection of 100% of site welds for moment connections.
 - .3 Magnetic particle inspection of randomly selected other site welds (5 to 10% of connections).
 - .4 Ultrasonic examination of 100% of complete penetration welds subject to tension and of 10% of those subject to compression.
 - .5 Review slip-critical connections to confirm that faying surfaces are free from oil and other deleterious substances, and that coatings, if any, are in compliance.
 - .6 Random verification that bolts are tightened in accordance with the turn-of-nut method on 10% of connections with pre-tensioned bolts.
 - .7 Random verification that bolts are snug tight and that connected plies are in firm contact on 10% of other bolted connections.
 - .8 Examine site applied coatings and application for compliance.
 - .9 Base plates and cap plates:
 - .1 Check grouting of column base plates and bearing plates to confirm compliance. Inspect at least three columns to confirm correct grouting procedures are used.
 - .2 Confirm that contact of base plates and levelling plates meets CSA S16 tolerances.
 - .3 Check for full bearing of column sections to base and cap plates.
 - .4 Check special bearing details of sliding expansion joint bearings.
 - .10 Check reinforcement and work around all holes and openings authorized to be cut at site.
- .2 Steel Deck: Perform the following inspections:
 - .1 100% visual inspection to confirm deck type, profile and galvanizing / coating; check that composite deck units have suitable lugs or deformations to provide composite action with concrete; obtain and review substantiating test data from Contractor.
 - .2 Random review of deck sheet thickness for +/- 10% of deck.
 - .3 Review the span layout (continuity) of the deck sheet over supports for compliance with the Contract drawings.
 - .4 100% visual review of deck side fastening sheet to sheet and fastening to supporting structure.
 - .5 Visually inspect welds for size, spacing, and workmanship.

- .6 Visually inspect mechanical fasteners for size, type, spacing, and workmanship.
- .7 Examine condition of supporting members after steel deck has been fastened to determine if supporting members were damaged.
- .8 Examine openings / cut-outs in the deck and confirm edge reinforcement.
- .3 Headed Shear Connectors: Perform the following inspections:
 - .1 Review supplier, grade, diameter, length, and head geometry for compliance.
 - .2 Confirm that Sub-Contractor uses proper procedures to determine generator, control unit, and stud welder settings at the start of each production period in accordance with CSA W59.
 - .3 Perform the following inspections:
 - .1 100% visual review of connector welds.
 - .4 Perform bend tests in accordance with CSA W59 if visual review indicates less than full 360-degree flash and hammer strike makes a dull sound indicating incomplete fusion.
- .4 Structural Fasteners: Perform the following inspections:
 - .1 100% visual inspection to confirm identification markings
- .5 Post-Installed Fasteners: Perform the following inspections:
 - .1 Initial inspection: encompasses the first ten (10) anchors of each type and size and consists of:
 - .1 Training certificates of installers
 - .2 Drill bit type and size
 - .3 Hole depth
 - .4 Hole cleaning technique
 - .5 Anchor type, size, embedment and installation procedure, including adhesive expiration date and proper dispensing if applicable.
 - .2 Subsequent installations of the same anchor size and type by the same personnel will proceed in the absence of the inspector, unless the inspector deems his presence is required, permanently or randomly.
 - .3 Any change in the anchor product being installed or the personnel performing the installation requires initial re-inspection by the inspector.
 - .4 Proof Testing: unless noted otherwise, proof load tests will be conducted on the initial ten (10) installations of each anchor type and at random on 5% of installed anchors; additional tests may be required where failures occur.
 - .1 Adhesive anchors will be tested to the lesser of 50% of the adhesive limit state bond strength or 80% of the steel anchor yield strength.
 - .2 Expansion anchors will be torque tested to 1.25 times the installation torque specified by the manufacturer.

END OF SECTION

Part 1 General

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM A36/A36M-19, Standard Specification for Carbon Structural Steel.
 - .2 ASTM A193/A193M-24, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High-Pressure Service and Other Special Purpose Applications.
 - .3 ASTM A307-21, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturers Association (CPMA).
 - .1 Handbook of the Canadian Institute of Steel Construction.
 - .2 CISC/CPMA Standard 2-75, Quick-Drying Primer for use on Structural Steel.
- .3 CSA Group (CSA)
 - .1 CSA G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA-G164-M2018 Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .3 CAN/CSA-S16-24, Limit States Design of Steel Structures.
 - .4 CAN/CSA-S136-2016, North American Specifications for the Design of Cold Formed Steel Structural Members.
 - .5 CSA W47.1-19, Certification of Companies for Fusion Welding of Steel.
 - .6 CSA W48-18, Filler Metals and Allied Materials for Metal Arc Welding.
 - .7 CSA W55.3-2008, Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.
 - .8 CSA W59-24, Welded Steel Construction (Metal Arc Welding).
- .4 Master Painters Institute
 - .1 MPI-INT 5.1, Structural Steel and Metal Fabrications.
 - .2 MPI-EXT 5.1, Structural Steel and Metal Fabrications.
- .5 The Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE) International
 - .1 NACE No. 3/SSPC SP-6-06, Commercial Blast Cleaning.
- .6 NACE International
 - .1 NACE International
 - .1 ANSI/NACE No. 13/SSPC-ACS-1-2016 -SG, Industrial Coating and Lining Application Specialist Qualification and Certification.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 – General Requirements.
- .2 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Yukon Territory, Canada.
- .3 Erection drawings:
 - .1 Submit erection drawings indicating details and information necessary for assembly and erection purposes including:
 - .1 Description of methods.
 - .2 Sequence of erection.
 - .3 Type of equipment used in erection.
 - .4 Temporary bracings.
- .4 Fabrication drawings:
 - .1 Submit fabrication drawings showing designed assemblies, components and connections are stamped and signed by qualified professional engineer licensed in the Yukon Territory, Canada.

- .5 Source Quality Control Submittals:
 - .1 Submit weeks prior to fabrication of structural steel.
 - .1 Mill test reports to show chemical and physical properties and other details of steel to be incorporated in project.
 - .2 Any material sourced outside of Canada or the United States shall have mill test reports certified by metallurgists qualified to practice in Yukon Territory.
- .6 Fabricator Reports:
 - .1 Provide structural steel fabricator's affidavit stating that materials and products used in fabrication conform to applicable material and products standards specified and indicated.
- .7 Certificates:
 - .1 Submit certifications for Application Specialists to demonstrate compliance to the requirements of ANSI/NACE No.13.

1.4 QUALIFICATIONS

- .1 Ensure that 50 % of persons, who perform concrete and steel surfaces preparation and coating applications, are certified by a recognized Applicator Certification Agency, in accordance with NACE 13/SSPC ACS-I, Applicator Certification Standard (ACS).
- .2 Maintain a current and valid ACS certification during project period.
 - .1 Application specialists who perform surface preparation and coating application work on this project must have a current ACS.
- .3 Notify Consultant of any change in application specialist certification status.
 - .1 Any delays to the completion of the Project due to invalid certifications will not be considered, and liquidated damages shall not be waived for any non-performance by Contractor.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 – General Requirements.
- .2 Deliver materials in manufacturer's original, undamaged containers with identification labels intact.
- .3 Packaging Waste Management: in accordance with Section 01 00 10 – General Requirements.

Part 2 Products

2.1 DESIGN REQUIREMENTS

- .1 Design details and connections in accordance with requirements of CSA to resist forces, moments, shears and allow for movements indicated.
- .2 Shear connections:
 - .1 Select framed beam shear connections from an industry accepted publication such as "Handbook of the Canadian Institute of Steel Construction" when connection for shear only (standard connection) is required.
 - .2 Select or design minimum end connection to resist reaction resulting from factored movement resistance as tabulated in the "Handbook of the Canadian Institute of Steel Construction" assuming 50% shear .
- .3 Submit sketches and design calculations stamped and signed by qualified professional engineer licensed in Yukon Territory, Canada for non standard connections.

2.2 MATERIALS

- .1 Structural steel: refer to drawings
- .2 Anchor bolts: refer to drawings
- .3 High strength anchor bolts: to ASTM A193/A193M, Grade as noted on drawings
- .4 Bolts, nuts and washers: to ASTM A325 / ASTM A325M.

- .5 Welding materials: to CSA W48 Series and certified by Canadian Welding Bureau.
- .6 Shop paint primer: to CISC/CPMA2-75 solvent reducible alkyd, grey
- .7 Hot dip galvanizing: galvanize steel, where indicated, to CAN/CSA-G164, minimum zinc coating of 600 g/m².
- .8 Shear studs: to CSA W59, Appendix H

2.3 FABRICATION

- .1 Fabricate structural steel in accordance with CAN/CSA-S16.
- .2 Install shear studs in accordance with CSA W59
- .3 Continuously seal members by where indicated by continuous welds. Grind smooth.

2.4 SHOP PAINTING

- .1 Clean, prepare surfaces and shop prime structural steel in accordance with CAN/CSA-S16.
- .2 Clean members, remove loose mill scale, rust, oil, dirt and foreign matter. Prepare surface according to NACE No.3/SSPC-SP-6
- .3 Apply one coat of primer in shop to steel surfaces except:
 - .1 Surfaces to be encased in concrete.
 - .2 Surfaces to receive field installed stud shear connections.
 - .3 Surfaces and edges to be field welded.
 - .4 Faying surfaces of slip-critical connections.
 - .5 Below grade surfaces in contact with soil.
- .4 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5 degrees C.
- .5 Maintain dry condition and 5 degrees C minimum temperature until paint is thoroughly dry.
- .6 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

Part 3 Execution

3.1 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 GENERAL

- .1 Structural steel work: in accordance with CAN/CSA-S16.
- .2 Welding: in accordance with CSA W59
- .3 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components

3.3 CONNECTION TO EXISTING WORK

- .1 Verify dimensions and condition of existing work, report discrepancies and potential problem areas to Consultant for direction before commencing fabrication.

3.4 MARKING

- .1 Mark materials in accordance with CSA G40.20/G40.21. Do not use die stamping. When steel is to be left in unpainted condition, place marking at locations not visible from exterior after erection
- .2 Match marking: shop mark bearing assemblies and splices for fit and match.

3.5 ERECTION

- .1 Erect structural steel, as indicated and in accordance with CAN/CSA-S16 and the approved shop drawings..
- .2 Field cutting or altering structural members: to approval of Consultant.
- .3 Clean with mechanical brush and touch up shop primer to bolts, rivets, welds and burned or scratched surfaces at completion of erection.

.4 Continuously seal members by continuous welds where indicated. Grind smooth.

3.6 FIELD QUALITY CONTROL

.1 The Consultant will review the Structural steel installation work. The Contractor to facilitate and provide all necessary means of support during the review.

.2 If work is found to lack conformance or quality, an independent testing agency may be required as the Consultant or Owner's instruction and paid for by the Contractor.

.3 Provide safe access and working areas for testing on site, as required by testing agency and as authorized by Consultant.

.4 Submit test reports to Consultant within 2 weeks of completion of inspection.

.5 Contractor will pay costs of all required testing.

.6 Test shear studs in accordance with CSA W59.

3.7 FIELD PAINTING

.1 Paint in accordance with Section 09 91 00 - Painting.

.1 Touch up damaged surfaces and surfaces without shop coat with primer to NACE No.3/SSPC-SP-6 except as specified otherwise. Apply in accordance: MPI Architectural Painting Specification Manual

3.8 CLEANING

.1 Clean in accordance with Section 01 00 10 – General Requirements.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM A653/A653M-23, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A780-20 Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.
 - .3 ASTM A792/A792M-2023, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .2 Canadian Sheet Steel Building Institute (CSSBI)
 - .1 CSSBI 10M-18, Standard for Steel Roof Deck.
 - .2 CSSBI 12M-18, Standard for Composite Steel Deck.
- .3 CSA Group (CSA)
 - .1 CSA C22.2 No.79-2016 (R2021), Cellular Metal and Cellular Concrete Floor Raceways and Fittings.
 - .2 CSA S16-24, Design of Steel Structures.
 - .3 CSA S136-16, North American Specification for the Design of Cold Formed Steel Structural Members
 - .4 CSA W47.1-19, Certification of Companies for Fusion Welding of Steel Structures.
 - .5 CSA W55.3-08 (R2023), Certification of Companies for Resistance Welding of Steel and Aluminum.
 - .6 CSA W59-24, Welded Steel Construction, (Metal Arc Welding) including Update No. 1 (2014), Update No. 3 (2015), Update No. 4 (2015).
- .4 Green Seal Environmental Standards (GS)
 - .1 GS-11-Edition 4.0 (2021), Paints and Coatings.
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-2016, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.2 DESIGN REQUIREMENTS

- .1 Design steel deck to CSA S136 and CSSBI 10M.
- .2 Design floor composite steel deck to CSA S16, CSA S136, and CSSBI 12M.
- .3 Steel deck and connections to steel framing to carry dead, live and other loads including lateral loads, diaphragm action, composite deck action, and uplift as indicated.
- .4 Metal deck is used as a lateral load resisting diaphragm. Metal deck thickness and connections specified on the drawings are the minimum required to resist the lateral loads. Thicknesses and connections may be increased by the supplier if necessary to resist vertical loadings.
- .5 Deflection under specified live load maximum 1/360 of span, except when gypsum board ceilings hung directly from deck, live load deflection maximum 1/420 of span.
- .6 Where vibration effects controlled as indicated, dynamic characteristics of decking system designed in accordance with CSA S16.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 – General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for steel decking and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in the Yukon, Canada.

- .2 Submit design calculations if requested by Consultant.
- .3 Indicate deck plan, profile, dimensions, base steel thickness, metallic coating designation, connections to supports and spacings, projections, openings, reinforcement details and accessories.
- .4 Indicate details of temporary shoring of steel deck, such as location, time and duration of placement and removal of shoring for concrete fill decks.

1.4 QUALITY ASSURANCE

- .1 Retain professional engineer registered or licensed in the Yukon, Canada, with experience in steel deck Work of comparable complexity and scope, to perform following services as part of Work of this Section:
 - .1 Structural design of steel deck and composite deck.
 - .2 Review, stamp, and sign Shop, shoring and erection Drawings, design calculations, and revisions required.
 - .3 Monitor supplier's and fabricator's quality control tests and reports.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect decking from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.6 SAFETY

- .1 Carry out work in accordance with the current Occupational Health and Safety Act and construction safety regulations.

Part 2 Products

2.1 MATERIALS

- .1 Zinc-iron Alloy (ZF) coated steel sheet: to ASTM A653/A653M structural quality Grade 255, with ZF75 coating, for interior surfaces not exposed to weather, unpainted finish, 0.91 mm minimum base steel thickness.
- .2 Decks to be painted: zinc-iron alloy coated decks suitable for finish painting.
- .3 Zinc (Z) coated steel sheet: to ASTM A653/A653M structural quality Grade 255, with ZF75, coating, regular spangle surface, chemically treated for unpainted finish, for exterior surfaces exposed to weather, 0.91 mm minimum base steel thickness.
- .4 Closures: as indicated in accordance with manufacturer's recommendations.
- .5 Cover plates, cell closures and flashings: steel sheet with minimum base steel thickness of 0.76 mm minimum. Metallic coating same as deck material.
- .6 Primer: to section 09 91 00 - Painting.

2.2 TYPES OF DECKING

- .1 Unless otherwise noted on drawings, steel roof deck: 0.91 mm minimum base steel thickness, 38 mm maximum deep profile. 1.21 mm base steel thickness required in some areas, see drawings.

2.3 FABRICATION

- .1 Fabricate metal deck in accordance with CSA-S136 and as recommended by the Canadian Sheet Steel Building Institute (CSSBI), the drawings and specifications and the reviewed shop drawings.
- .2 Verify dimensions of existing work prior to commencing fabrication.

- .3 Verify all drawing dimensions and conditions prior to commencing fabrication.
- .4 Ensure the metal decking is continuous over three or more spans unless otherwise approved.
- .5 Provide a male and female lip for each section of the metal decking

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts acceptable for steel decking installation in accordance with manufacturer's written instructions.
 - .1 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation after unacceptable conditions remedied and after receipt of written approval to proceed from the consultant.

3.2 PREPARATION

- .1 Locate bundles of deck materials to prevent overloading of supporting members.
- .2 Install temporary shoring before placing deck panels, if required to meet deflection limitations.

3.3 ERECTION

- .1 Structural steel work: in accordance with CSA S136.
- .2 Welding: in accordance with CSA W59, except where specified otherwise.
- .3 Fastening: Fasten to Glulam Beams with Screws as shown in the structural drawings
- .4 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel or CSA W55.3 for resistance welding.
- .5 Erect steel deck as indicated and in accordance with CSA S136 and in accordance with reviewed erection drawings.
- .6 Lap ends: to 150 mm minimum.
- .7 Immediately after deck is permanently secured in place, touch up metallic coated top surface with compatible primer where burned by welding.
- .8 Openings and Areas of Concentrated Loads
 - .1 No reinforcement required for openings cut in deck maximum 150 mm square.
 - .2 Frame deck openings with dimension between 150 to 300 mm as recommended by manufacturer, except as otherwise indicated.
 - .3 For deck openings with dimension minimum 300 mm and for areas of concentrated load, reinforce in accordance with structural framing details, except as otherwise indicated.
- .9 Connections: Install connections in accordance with CSSBI recommendations as indicated.

3.4 FIELD TOUCH-UP PAINTING

- .1 Upon erection completion, mechanically brush clean bolts, rivets, welds, and burned or scratched surfaces.
- .2 For galvanized steel surface with damage and without shop coat, repair with field touch up primer.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by steel decking installation.

3.6 CLEANING

- .3 Clean up and remove all debris and excess material from the site as work is in progress.

3.7 CERTIFICATION

- .1 Certify at the completion of work, under the seal and signature of the Contractor's professional engineer responsible for this work, that all connections and components designed by the Contractor are capable of supporting the loads and forces indicated in

the contract specifications and on the contract drawings and that all connections and components are fabricated and installed in accordance with the reviewed shop drawings.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide Cold-formed Metal Framing in accordance with requirements of the Contract Documents.

1.2 References

- .1 American Iron and Steel Institute (AISI):
- .1 AISI S100 "North American Specification for the Design of Cold-Formed Steel Structural Members".
 - .2 AISI "Code of Standard Practice for Cold-Formed Steel Structural Framing".
- .2 American Society of Mechanical Engineers International (ASME):
- .1 ASME B18 Series Codes and Standards as referenced for specific screws, nuts, bolts and other fasteners.
- .3 ASTM International (ASTM):
- .1 ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
 - .2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .3 ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus
 - .4 ASTM C954, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
 - .5 ASTM C1002, Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
 - .6 ASTM C1007, "Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories".
 - .7 ASTM C1177/C1177M, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
 - .8 ASTM F3125/F3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength
- .4 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating (withdrawn)
- .5 CSA Group (CSA):
- .1 CAN/CSA S136, North American Specification for the Design of Cold Formed Steel Structural Members
 - .2 CSA W47.1, Certification of Companies for Fusion Welding of Steel
 - .3 CSA W59, Welded Steel Construction (Metal Arc Welding)

1.3 System Description

- .1 Cold-Formed Steel Framing Design Standards: Design according to AISI's S100 "North American Specification for the Design of Cold-Formed Steel Structural Members".

- .2 Provide exterior wall stud framing system to resist wind loads, to accommodate doors, windows and exterior finishes, consisting of the following components:
 - .1 Studs.
 - .2 Top and bottom tracks.
 - .3 Bridging and bracing.
 - .4 Top and bottom track connections to main structure, including fabrications to accommodate main structure deflections.
 - .5 Head, sill and jamb members at wall openings.
 - .6 Framing component connections.
- 1.4 Submittals
 - .1 Action Submittals: Provide the following submittals before starting any work of this Section:
 - .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
 - .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings for the fabrication and installation of the Work. Prepare details at not less than 1:5 minimum scale. Show typical details of the conditions for every member, joint, anchorage and support in the system.
 - .2 Information Submittals: Provide the following submittals for Consultant's information:
 - .1 Structural Calculations: Furnish engineering calculations to show that maximum stresses and deflections do not exceed specified performance requirements under full design loading. Calculations shall be prepared and sealed by a qualified Structural Engineer licensed in the Yukon Territory.
- 1.5 Quality Assurance
 - .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
 - .2 Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of National, Provincial and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.
 - .3 Engage a professional structural engineer registered in the Yukon Territory fully qualified and experienced in the design of structural steel studs to be responsible for the design of the structural steel studs and connection of the top and bottom track to the supporting structure, and to prepare, seal, and sign all shop drawings and to perform field reviews.
 - .4 The Contractor's Professional Engineer responsible for this work is to inspect the fabrication and erection of all steel studs and components in accordance with APEGA "Responsibilities for Engineering Services on Building Projects" - current edition.
 - .5 Work of this Section must be performed by a company that specializes in the type of cold formed metal framing work required for this project, with a minimum of 5 years of documented successful experience and work must be performed using skilled workers thoroughly experienced in the necessary crafts.
 - .6 Use a steel stud manufacturer who specializes in the manufacturing of the type of cold formed metal framing specified in this Section with a minimum of 5 years of documented successful experience, and have the facilities capable of meeting all requirements of the Contract Documents as a single-source responsibility and warranty.
 - .7 Use installers who are experienced in performing work of this Section who has specialized in installation of work similar to that required for this project.

- .8 Product Tests: mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility and metal coating thickness.
- .9 Fire Test Response Characteristics: where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance as per CAN/ULC-S101 by a testing and inspection agency acceptable to authorities having jurisdiction.
- .10 Comply with ANSI "North American Specification for the Design of Cold-Formed Steel Structural Members" and "Standard for Cold Formed Steel Framing - General Provisions".
- .11 Comply with LGSEA Research Note "Behaviour and Design of Self-Drilling Screw Connections".
- .12 Pre-installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

2. PRODUCTS

2.1 Design Requirements

- .1 Design steel stud assemblies in accordance with CAN/CGSB-7.1-98 and CSA-S136, limit states design principles using factored loads and resistances, to support all loads and forces indicated on the drawings and as specified.
- .2 Design cold formed structural steel framing systems to resist wind loads for the Whitehorse area using building code climatic data: 1 in 50 year loads for strength and 1 in 10 year loads for deflection including $I_w = 1.25$.
- .3 Calculate loads and load factors in accordance with the National Building Code of Canada 2020.
- .4 Determine resistances and resistance factors in accordance with the National Building Code of Canada 2020 and CSA-S136.
- .5 Design system to accommodate construction tolerances, deflection of building structural members and clearances of intended openings.
- .6 Except where otherwise noted on the drawings, size components and design connections for bottom and top track to base structure to resist all design loads including lateral loads in accordance with the NBC 2020.
- .7 Design bridging to prevent rotation and translation and ensure structural integrity.
- .8 Design exterior stud systems to provide a maximum deflection of $L/360$ in accordance with CSA S136. Limit free play and movement in connections perpendicular to the plane of the framing to 2 mm relative to the building structure.
- .9 Stud widths are indicated on the drawings. Adjust stud material thickness and stud spacing or both as required by design criteria. Use greater or less stud widths only if accepted by the Consultant.
- .10 Design metal stud system and attachments to accommodate the full range of tolerances permitted in adjoining materials.
- .11 Design stud end connections to accommodate structural deflections, frame shortening, and vertical tolerances permitted in structure such that studs are not loaded axially. Provide for differential in floor to head height for all effects combined.

- .12 Take into account local loadings due to anchorage of cladding and interior wall mounted fixtures where indicated.
- .13 Design bridging to prevent member rotation and member translation perpendicular to the minor axis for lateral load bearing studs. Provide for secondary stress effects due to torsion between lines of bridging. Do not rely on cladding, sheathing, or insulation for lateral bracing. Provide metal bridging at 1500 mm o.c. maximum. Use closer spacing if required by structural design.
- .14 Reinforce steel studs where flanges are cut out. Reinforcement to develop full capacity of stud section.
- .15 Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to maximum ambient temperature change (range) of 67 degrees C.
- .16 Conform to the requirements of fire rated assemblies indicated, which have been tested in accordance with CAN/ULC-S101.

2.2 Load-Bearing Metal Stud Framing

- .1 Member configurations and cutouts: to CAN/CGSB-7.1.
- .2 Steel studs: roll-formed of galvanized steel sheet of thickness and profile dictated by design, with minimum base metal thickness of 1.092 mm, "C" Shaped with flanges not less than 32 mm wide, edges bent back 90E and doubled over to form a 5 mm return. Faces knurled. Widths as noted on the drawings. Identified as to thickness of indelible markings or colour coded by thickness as follows:
 - .1

Colour Nominal	Base Metal thickness, mm (gauge)
White	0.762 mm (20 gauge)
Yellow	1.092 mm (18 gauge)
Green	1.372 mm (16 gauge)
Orange	1.727 mm (14 gauge)
- .3 Floor and overhead tracks: cold-formed of same kind of steel sheet as studs, base metal thickness to match studs or greater thickness as determined by the Contractor's Engineer and as indicated on the reviewed shop drawings, identified or colour coded in same manner as studs, top and bottom track to structural studs at exterior walls, 32 mm flange height for bottom tracks, 50 mm flange height for top tracks.
- .4 Bracing channels: except as noted otherwise 38 mm x 12.7 mm x 1.372 mm (16 gauge) minimum base metal thickness, cold formed of galvanized steel sheet or heavier as dictated by design. Where appropriate, light gauge metal framing members may be used in lieu of channels.
- .5 Metal Channel Stiffeners: 38 mm x 90 mm size, 1.092 mm base metal thick cold rolled galvanized steel sheet.
- .6 Bracing Clips: angles of 1.372 mm minimum base metal thickness galvanized steel sheet, with 38 mm legs and length less than stud width by up to 13 mm, pre-punched for screw attachment to studs and bracing.

- .7 Cutouts: provide cutouts to fit bracing at intervals of 600 mm o.c.; centre cutouts on web of studs, limit unreinforced cutouts to the following dimensions (in mm):

Member Depth	Max. Across Member Depth	Max. Along Member Length	Min. Centre to Centre Spacing	Min. from End
92	40	105	600	300
100	40	105	600	300
150	65	115	600	300

2.3 Fasteners

- .1 Concrete Anchors: threaded fasteners designed to screw into pre-drilled holes in concrete, or drilled adhesive-set stud anchors; with minimum shank diameter of 8 mm minimum or larger diameter as required to suit design, of 400 series stainless steel coated with zinc and dichromate conversion coating. Power actuated fasteners are not permitted.
- .2 Bolts and Nuts: to ASTM A307, with large flat washers, hot dip galvanized steel.
- .3 Screws: hex, pan or wafer head, self drilling, self-tapping sheet metal screws, 400 series stainless steel fasteners coated with zinc or cadmium and dichromate conversion coating. Select fasteners known not to strip with the combination of material thickness being fastened and tools to be used. Use flat headed screws to fasten sheet metal blocking to steel studs, and studs to lower top track of double top track installation to allow for unrestricted vertical movement to accommodate structural deflection from above.

2.4 Accessories

- .1 Metal strip 'blocking': 1.092 mm(18 ga.) steel sheet, 150 mm wide or wider as required to accommodate materials or equipment being fastened to the blocking.
- .2 Fire safing filler: rock wool or mineral fibre, one of the following:
- .1 'Firebarrier'.
 - .2 'Firestop'.
 - .3 Rockwool 07840 Safe.
- .3 Foam strip: continuous, closed cell self adhering foam tape, 6 mm thick x 25 mm width.

2.5 Sheathing

- .1 Plywood Sheathing: Refer to Section 06 10 00.
- .2 Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117.
- .1 For steel framing less than 0.835 mm thick, use screws that comply with ASTM C1002.
 - .2 For steel framing from 0.84 to 2.84 mm thick, use screws that comply with ASTM C954.

3. EXECUTION

3.1 Examination

- .1 General: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 Installation Cold Formed Metal Framing

- .1 General: Provide cold-formed metal framing construction in accordance with requirements of ASTM C1007 and the framing manufacturer's recommendations for each particular application, except where more stringent requirements are shown or specified. Set framing accurately in location, alignment and elevation, plumb, level and true, within tolerances indicated by accepted shop drawings, as measured from established building lines and from other Work already in place.
- .2 Connections: Fasten framing members as indicated and in accordance with manufacturer's recommendations. Where welds are required, comply with CSA Standards for structural welding procedures. Except where otherwise shown, fasten framing to solid concrete or masonry with expansion bolts.
- .3 Coordination: Furnish assistance and information to other trades as necessary for connections of their Work with the framing system. Refer to Division 07 cladding sections, for anchorage of cladding at load-bearing stud framing.

3.3 Erection

- .1 Install steel studs and accessories in accordance with AWCC Specification Standards Manual Section 9.3, ASTM C1007 and with manufacturer's recommendations and as indicated on the reviewed shop drawings signed and sealed by the Contractor's Engineer.
- .2 Construct framing piece by piece (stick built), or by fabricating into panels either on or off site.
- .3 Execute work neatly and accurately, plumb and true, coordinated with work of other trades to tolerances specified. Take actual built dimensions of previously constructed work into account and accommodate them by adjusting position of framing as may be required. Make all field measurements necessary to ensure fit of all members.
- .4 Provide temporary bracing, if required for framing to sustain loads applied during erection and subsequent construction.
- .5 Do not place non-axial load bearing studs extending to the underside of structural elements such as floor slabs, roof slabs and the like, until all dead loading (ie. roof system, roofing materials, mechanical units and the like) has been placed on structure above. To locations where there are floor slabs above, pre-load floor slabs prior to installation of steel studs extending to underside of structure.
- .6 Erect load bearing studs one piece, full length. Splicing of studs is not permitted.
- .7 Align walls correctly on approved lay-out.
- .8 Install dampproof course under stud shoe tracks of partitions on slabs on grade.
- .9 At exterior walls, install bottom track in two continuous beads of sealant.
- .10 Use nested inner and outer track for attachment to overhead structures. Leave a minimum gap of 25 mm to accommodate structural movement.

- .11 Floor and overhead tracks:
- .1 For steel stud assemblies extending to underside of structure, anchor galvanized sheet metal channel retaining the top track (for deflection control) underside of structure using drilled screw on fasteners at maximum 600 mm o.c. to concrete structure or shorter spacings as required to suit design. Form the upper track 1.6 mm wider to nest with the lower. Screw studs to the lower track, near the bottom edge of the flange. **DO NOT SCREW STUDS OR TOP CHANNEL THROUGH TO RETAINING CHANNEL.**
 - .2 Install top and bottom track in continuous bead of sealant. Also, apply a continuous bead of sealant between studs and dissimilar adjacent materials.
 - .3 Where top track is exposed to permit structural deflection, place 'Fire Safing Filler' in track before installing studs. Install fire safing insulation between double track.
 - .4 Secure floor track in place to concrete slab, at 600 mm o.c. or shorter spacings as required to suit design, using drilled screw on fasteners or other approved fasteners.
 - .5 Place one additional anchor within 100 mm of each end of each piece of bottom and top track.
 - .6 Secure floor and ceiling track to short walls, 150 mm in length or less before change in direction, using minimum 3 drilled anchors, to securely fasten in place.
- .12 Erect studs plumb and in alignment, and attach to legs of top and bottom tracks with one No.6 screw at each connection (4 per stud).
- .13 Position studs vertically in the tracks, spaced not more than 400 mm o.c., unless indicated otherwise and not more than 50 mm from abutting walls, and at each side of openings and corners. Screw fix studs to both sides of top and bottom track to exterior stud partition locations. At door frames and other frames, double up jamb studs. Use 1.2 mm thick studs at both door jambs. Use structural studs to both jambs at all door openings.
- .14 Brace steel studs with horizontal bracing channels through stud cutouts at 1220 mm maximum vertical centres. Fasten bracing to each stud with bracing clips using four (4) No. 8 screws.
- .15 Install bracing in longest practical lengths. Where splices are required make them more than one stud space long, with each end fastened at a bracing clip. Install all bracing as noted on the reviewed shop drawings, and as otherwise may be required to secure partitions and bulkheads in place and to provide lateral support.
- .16 Reinforce cutouts which occur within 300 mm of the end of a stud. Align stud cut-outs horizontally. Do not allow additions cutouts to be made in field, except as approved by the Engineer responsible for the preparation of shop drawings.
- .17 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.
- .18 Frame all openings in stud walls, except openings less than 100 mm in any dimension, and provide framing at points of attachment of wall mounted fixtures to adequately carry loads by using additional framing members and bracing.
- .19 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.
- .20 Set door and similar frames into position, align and brace securely until properly anchored. Anchor bottom of door frames to floors with drilled inserts. Install temporary horizontal spreader at door mid-height to ensure maintenance of frame width until adjacent work is completed. After removing bottom (steel) spreader, grind frame smooth.

- .21 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs. Secure track to studs at each end, in accordance with manufacturer's instructions. Install intermediate studs above and below openings in same manner and spacing as wall studs.
- .22 Frame openings and around built-in equipment, cabinets, access panels, on four sides.
- .23 Extend framing into reveals. Check clearances with equipment suppliers.
- .24 At openings, install cut-to-length sections of track with web flanges bent at each end and securely attached to jamb studs. Install infill studs above or below opening as applicable. Where directed, place end infill studs so that it is possible to have a control joint in line with a door jamb.
- .25 Use screws long enough to penetrate beyond joined materials by more than three (3) exposed threads. Use wafer-head fasteners where panel products will be installed against the attachment.
- .26 Use screws with drilling and holding capabilities recommended by the manufacturer for the materials being fastened. Select different screws if initial selection fails to drill effectively or tends to strip out.
- .27 Install header framing suspended from structure using screws only.
- .28 Extend all metal stud partitions to underside of structure except where indicated otherwise.
- .29 Allow for 15 mm live load deflection on all stud walls which terminate at underside of structure.
- .30 Install steel studs or furring channel between studs for attaching electrical and other boxes.
- .31 Form control joints in long runs of wall. Place double studs so that control joints will be no more than 9 m apart.
- .32 Install continuous strip of foam tape between stud framing and exterior window wall frames. Do not penetrate window wall mullions and radiation cabinets with screws or other fasteners.

3.4 Blocking

- .1 Install metal strip blocking for fixing of wall mounted items. Confirm blocking requirements before applying gypsum board. If this is not done, and blocking is required, remove and replace board at own expense. Screw to face of studs using self-tapping flat headed screws at 150 mm o.c. maximum along each stud, with a minimum of 2 screws per stud.
- .2 Install metal blocking or 89 mm stud install on flat and horizontally between vertical studs, behind all wall mounted door stops. Screw fasten blocking or stud to adjacent studs.
- .3 Coordinate installation of wood and plywood blocking and backing, with Section 06 10 00.

3.5 Tolerances

- .1 Plumb: 1/500 of member length maximum.
- .2 Straightness (camber and sweep): 1/1000 of member length, maximum. Replace members with local buckling or bends.
- .3 Spacing: not more than 3 mm from design spacing, non-cumulative.
- .4 Location: within 10 mm of indicated alignment, and within 5 mm where alignment of structure permits.
- .5 Gap between end of stud and web of track (where connected): 4 mm maximum.

- .6 Alignment of members in same plane, where supporting continuous cladding or sheathing: 1 mm maximum.
- .7 Limit of acceptable distortion of hollow metal door frames (and similar frames) - out of plumb measured on face of frames 1.5 mm, maximum twist corner to corner 3 mm.
- 3.6 Galvanized and Zinc Coating Repairs
 - .1 Prepare and repair damaged galvanized and zinc coatings on fabricated and installed cold- formed metal framing using galvanized repair paint in accordance with ASTM A780 and manufacturers recommendations.
- 3.7 Field Quality Control
 - .1 Ensure that the Contractor's Engineer responsible for design of the metal stud system, and preparation of shop drawings, reviews the Work in progress at the site regularly during construction and submit field reports to the Consultant for each visit.
 - .2 Include in these field reviews, review of mill test reports, member sizes and material thickness, coating thicknesses, screwed connections, erection tolerances, and all field cutting, including cutting and patching for other trades.
- 3.8 Clean Up
 - .1 Upon completion of work of this Section, remove from site all debris and sweep vacuum or otherwise remove all debris; leave area clean and tidy to the satisfaction of the Consultant.
- 3.9 Contractor's Engineer's Confirmation Letter
 - .1 At the completion of work, provide to the Consultant, a letter from the Contractor's Engineer confirming that:
 - .1 All structural wind bearing metal studs and components are fabricated and erected in conformance with his design.
 - .2 All steel studs are capable of supporting all the loads specified or indicated on the reviewed shop drawings.
 - .3 All structural wind bearing metal stud systems have been designed and installed to conform with the seismic restraint requirements of the National Building Code of Canada 2020.
 - .4 All components are fabricated and erected in accordance with the reviewed shop drawings.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide metal fabrications in accordance with requirements of the Contract Documents.

1.2 References

.1 ASTM International (ASTM):

- .1 ASTM A36/A36M, Standard Specification for Carbon Structural Steel
- .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless
- .3 ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- .4 ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- .5 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes
- .6 ASTM A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
- .7 ASTM A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- .8 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) By The Hot Dip Process
- .9 ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- .10 ASTM A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- .11 ASTM A786/A786M Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
- .12 ASTM A793, Standard Specification for Rolled Floor Plate, Stainless Steel
- .13 ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
- .14 ASTM B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- .15 ASTM C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- .16 ASTM D1187/D1187M, Standard Specification for Asphalt Base Emulsions for Use as Protective Coatings for Metal
- .17 ASTM F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

.2 Canadian Standards Association (CSA):

- .1 CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
- .2 CSA W59, Welded Steel Construction (Metal Arc Welding)

.3 The Society for Protective Coatings (SSPC): "Steel Structures Painting Manual, Volume 2, Systems and Specifications".

1.3 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.

- .1 Furnish technical data describing the quality and performance of each material component or system to be used in the Work, e.g., the type of metal, load assumptions, or other such primary characteristics as required by the Drawings or Specifications.

- .2 Furnish manufacturer's specifications for materials, load tables, dimension diagrams, and installation instructions.
- .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings for the fabrication and installation of the Work. Include plans, elevations and sections at not less than 1:10 scale. Prepare details at not less than 3" = 1'-0" [1:5] minimum scale. Show typical details of the conditions for every member, joint, anchorage and support in the system.
 - .1 Drawings for ladders, railings, and stairs shall be prepared and sealed by a qualified Structural Engineer licensed in the Yukon Territory.
- .3 Samples: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for color and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor.
- .4 Structural Calculations: Submit for Consultant's information. Furnish engineering calculations for metal fabrications shown conceptually on the Drawings to show that maximum stresses and deflections do not exceed specified performance requirements under full design loading. Identify all loads that will be imposed on the structural system of the building. Calculations shall be prepared and sealed by a qualified Structural Engineer licensed in the Yukon Territory.
- .5 Quality Control Submittals: Submit for Consultant's information.
 - .1 Inspection and Test Reports: Furnish reports of the specified inspections and tests.
- 1.4 Quality Assurance
 - .1 Regulatory Requirements: Perform structural welding, use personnel and qualify procedures in accordance with requirements.
 - .2 Qualifications: Provide proof of qualifications:
 - .1 Fabricators: Use fabricator experienced in producing metal fabrications similar to those required for this project and with a record of successful in-service performance with sufficient production capacity to produce required units.
 - .2 Personnel: Use welders qualified by Canadian Welding Bureau for classification of work being performed that are experienced in type and extent of work required for the project.
- 1.5 Project Conditions
 - .1 Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where metal fabrications are indicated to fit walls and other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - .2 Established Dimensions: Establish dimensions and proceed with fabricating metal fabrications without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for trimming and fitting.
- 2. **PRODUCTS**
 - 2.1 Materials
 - .1 Metal Surfaces: Provide materials with smooth, flat surfaces without blemishes for metal fabrications exposed to view in the completed Work; do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
 - .2 Ferrous Metals:
 - .1 Steel Plates, Shapes, and Bars: In accordance with CAN/CSA G40.20/G40.21, Grade 300W or ASTM A36/A36M.

- .2 Hollow Structural Sections: In accordance with CAN/CSA G40.20/G40.21, Grade 350W, Class C.
- .3 Stainless Steel Sheet, Strip, Plate, and Flat Bars: In accordance with ASTM A666, Type 304.
- .4 Stainless Steel Bars and Shapes: In accordance with ASTM A276, Type 304.
- .5 Rolled Steel Floor Plate: In accordance with ASTM A786/A786M, rolled from plate meeting requirements for ASTM A36/A36M or ASTM A283/A283M, Grade C or D
- .6 Rolled Stainless Steel Floor Plate: In accordance with ASTM A793
- .7 Steel Tubing: Cold formed steel tubing in accordance with ASTM A500.
- .8 Steel Pipe: In accordance with ASTM A53/A53M, standard weight (Schedule 40) Welding Rods and Bare Electrodes: Select according to CWB specifications for metal alloy welded.
- .9 Welding Rods and Bare Electrodes: Select according to CWB specifications for metal alloy welded.
- .3 Non-Ferrous Metals:
 - .1 Aluminum Extrusions: In accordance with ASTM B221, alloy 6063-T6
 - .2 Aluminum Alloy Rolled Tread Plate: In accordance with ASTM B632/B632M, alloy 6061-T6
- .4 Cementitious Materials:
 - .1 Grout: Non-Shrink, Non-Metallic Grout: Factory packaged, non-staining, non-corrosive, non-gaseous grout in accordance with ASTM C1107, specifically recommended by manufacturer for interior and exterior applications.
 - .2 Concrete: Provide concrete meeting requirements of Structural for normal weight, air entrained, ready mix concrete having a minimum 28 day compressive strength of 20 MPa.
- .5 General Fasteners: Provide Type 304 or 316 stainless steel fasteners for exterior use and zinc plated fasteners with coating in accordance with ASTM B633, Class Fe/Zn 5, where built into exterior walls; select fasteners for type, grade and class required and selected from the following:
 - .1 Anchor Bolts: ASTM F1554, Grade 36.
 - .2 Machine Screws: ASME B18.6.3/B18.6.7M.
 - .3 Plain Washers: Round, carbon steel, ASME B18.22.1/B18.22M.
 - .4 Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1/B18.21.2M.
- .6 Finishes: Finish metal fabrications in accordance with NAAMM Metal Finishes Manual for Architectural and Metal Products following recommendations for applying and designating finish after assembly and as follows:
 - .1 Steel and Iron Finishes:
 - .1 Galvanizing: Hot dip galvanize items as indicated in accordance with applicable standard following:
 - Products: ASTM A123/A123M
 - Hardware ASTM A153/A153M
 - .2 Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces in accordance with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - Exteriors SSPC Zone 1B: SSPC-SP6, Commercial Blast Cleaning
 - Interiors SSPC Zone 1A: SSPC-SP3, Power Tool Cleaning
 - .2 Stainless Steel Finishes: Remove tool and die marks and stretch lines or blend into finish; grind and polish surfaces to match original finish; passivate and rinse surfaces after polishing, remove embedded foreign matter and leave surfaces chemically clean.
 - .3 Aluminum Finishes: As-Fabricated Finish, AA-M10, mill finish

- .4 Applied Finishes: Apply finishes to uncoated surfaces of metal fabrications, except items with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry in accordance with SSPC-PA1, Paint Application Specification No. 1 and as follows:
 - .1 Shop Primers: Provide primers that are compatible with paint AA-M110 systems specified in Section 05 05 19 and Section 09 91 00.
 - .2 Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in steel, in accordance with SSPC-Paint 20, coordinate requirements with Section 05 05 19.
 - .3 Bituminous Paint: Cold applied asphalt mastic in accordance with SSPC-Paint 12; except containing no asbestos fibres, or cold applied asphalt emulsion in accordance with ASTM D1187/D1187M.

2.2 Fabrication

- .1 Shop Fabrication: Shear and punch metals cleanly and accurately, remove burrs; ease exposed edges to a radius of approximately 1 mm; form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work and as follows:
 - .1 Fabricate joints exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate
 - .2 Fabricate assemblies exposed to exterior conditions that allow for thermal movement resulting from ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects.
 - .3 Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
 - .4 Remove sharp or rough areas on exposed traffic surfaces.
- .2 Shop Welding: Weld corners and seams continuously and as follows:
 - .1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals
 - .2 Obtain fusion without undercut or overlap
 - .3 Remove welding flux immediately
 - .4 At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface
- .3 Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize site splicing and assembly and as follows:
 - .1 Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - .2 Use exposed fasteners of type indicated; or if not indicated, Phillips flat-head countersunk screws or bolts.
 - .3 Locate joints where least conspicuous.
 - .4 Disassemble units only as necessary for shipping and handling limitations
 - .5 Use connections that maintain structural value of joined pieces
 - .6 Clearly mark units for reassembly and coordinated installation
- .4 Anchorage Fabrication: Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support required loads; provide for anchorage of type indicated and suitable for supporting structure, and as follows:
 - .1 Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

3. EXECUTION

3.1 Installation

- .1 Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.
- .2 Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels and as follows:
 - .1 Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
 - .2 Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
- .3 Site Welding: Perform welding work in accordance with CSA W59; do not weld, cut or abrade surfaces of exterior units that have been hot dip galvanized after fabrication and are for bolted or screwed site connections and as follows:
 - .1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - .2 Obtain fusion without undercut or overlap.
 - .3 Remove welding flux immediately.
 - .4 At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- .4 Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with bituminous paint applied to a high build thickness of 1.5 to 2 mm.

3.2 Adjusting and Cleaning

- .1 Touch-Up of Shop Applied Primer: Immediately after erection, clean site welds, bolted connections, and abraded areas of shop coatings, and recoat exposed areas using same material as used for shop priming in accordance with SSPC-PA1 for touching up shop coated surfaces; apply by brush or spray to a minimum 0.05 mm dry film thickness.
- .2 Galvanized Surfaces: Clean site welds, bolted connections, and abraded areas and repair galvanizing in accordance with ASTM A780.

3.3 Schedule of Components

- .1 The following listing of metal fabrications is provided by the Consultant for the convenience of the Contractor every attempt has been made to provide a complete list of metal fabrications; however, it is not intended to be a comprehensive listing, which is the Contractor's responsibility; list of metal fabrications includes; but is not limited to, the following:
 - .1 Loose Bearing and Levelling Plates: Provide plates for steel items bearing on masonry or concrete construction; drill plates to receive anchor bolts and for grouting; galvanize plates after fabrication
 - .2 Shelf Angles: Steel angles with horizontally slotted holes to receive 19 mm bolts, spaced not more than 150 mm from ends and 610 mm \varnothing /c, provide vertical channel brackets to support angles from backup masonry and concrete; align expansion joints in angles to coincide with control and expansion joints in cavity wall exterior wythe; galvanize where located in exterior walls.

- .3 Miscellaneous Framing and Supports: Structural steel shapes, plates, and bars of welded construction; galvanize where located in exterior construction; fabricated to sizes, shapes, and profiles necessary to receive adjacent construction retained by framing and supports; cut, drill, and tap units to receive hardware, hangers, and similar items including but not limited to the following:
 - .1 Support angles for elevator door sills
 - .2 Elevator machine beams
 - .3 Steel framing and supports for operable partitions and skyfold partitions
 - .4 Steel framing and supports for countertops
 - .5 Steel framing and supports for mechanical and electrical equipment
 - .6 Steel framing and supports for applications where framing and supports are not specified in other Sections
 - .7 Steel angle corner guards (non-decorative)
 - .8 Miscellaneous steel trim
 - .9 Structural steel door frames
 - .10 Steel floor plate and supports
 - .11 Steel framing and overhead beam for operable partitions
- .4 Pipe Guard Posts (Bollards): Schedule 40 steel pipe filled with concrete formed with a rounded top; embedded 1200 mm into concrete pile with 1200 mm exposed; prime and paint finish. Colour as selected by Consultant.
- .2 Knife Plates at exterior cladding: refer to details. Galvanize and paint finish.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide rough carpentry in accordance with requirements of the Contract Documents.

1.2 References

- .1 American National Standards Institute (ANSI):

.1 ANSI/TIA/EIA 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces

- .2 ASTM International (ASTM):

.1 ASTM A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

.2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

.3 ASTM C954, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness

.4 ASTM F1482, Standard Practice for Installation and Preparation of Panel Type Underlayments to Receive Resilient Flooring

- .3 American Wood Preservers Association (AWPA):

.1 AWPA Book of Standards

- .4 Canadian Standards Association (CSA):

.1 CSA B111, Wire Nails, Spikes and Staples

.2 CAN/CSA O80 Series, Wood Preservation

.3 CSA O86, Engineering Design in Wood

.4 CAN/CSA-O141, Softwood Lumber.

.5 CSA O325, Construction Sheathing

.6 CSA S16, Design of steel structures, Includes Update No. 1

.7 CSA T530, Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A)

- .5 National Lumber Grading Association (NLGA):

.1 NLGA Canadian Lumber Grading Rules

1.3 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.

- .2 Certifications: Submit for Consultant's information.

.1 Preservative Treatment: Submit certification signed by the producer for each batch of preservative treated material, identifying the product name; the intended use and exposure conditions; the specific regulations and AWPA standards followed; the preservative chemicals and net retention in the wood. Include a warranty that treatment meets specified requirements and shall not form surface deposits nor adversely affect fasteners or decorative coatings in connection with the treated material.

- .2 Fire Retardant Treatment: Submit certification signed by the producer for each batch of fire retardant treated material, identifying the product name; the intended use and exposure conditions; the specific regulations and AWPA standards followed; the fire retardant chemicals and net retention in the wood. Include a warranty that treatment meets specified requirements and shall not form surface deposits nor adversely affect fasteners or decorative coatings in connection with the treated material.

1.4 Quality Assurance

- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- .2 Identify lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

1.5 Delivery, Storage and Handling

- .1 General: Keep materials dry during delivery, storage and installation, until finish is applied and building is enclosed. Store material at the site off the ground, separated to facilitate air circulation around all sides and in such a manner to protect from the weather and damage during construction operations.
- .2 Protect materials from weather in transit and on the jobsite.
- .3 Store materials a minimum of 150 mm off the ground on framework or blocking and cover with protective waterproof covering, providing for air circulation and ventilation under the covering.
- .4 Do not store seasoned materials under conditions that will cause their moisture content to increase.
- .5 Protect edges and corners of sheet materials from damage during handling and storage.
- .6 Store preservative-treated materials under cover, off the ground and protected from moisture.

1.6 Certificates

- .1 For products treated with preservative or fire-retardant by pressure impregnation submit following information certified by authorized signing officer of treatment plant:
 - .1 Information listed in AWPA M2 applicable to specified treatment.
 - .2 Moisture content after drying following treatment with water-borne preservative or fire retardant.
 - .3 Indicate acceptable types of paint, stain, and clear finishes that may be used over treated materials to be finished after treatment.

1.7 Pre-Construction Meeting

- .1 A pre-construction will be held prior to starting structural framing and framing of sound rated partition walls.
- .2 Construction of these wall assemblies requires a detailed knowledge of specific installation techniques. No work shall proceed until meeting has been completed.
- .3 Attendees of meeting will include, but not be limited to, the Consultant, Construction Manager, the Trade Contractor and their personnel.

2. PRODUCTS

2.1 Grades

- .1 Use CLS grade-marked lumber conforming to the Standard Grading Rules for Canadian Lumber published by the National Lumber Grades Authority.

2.2 Lumber

.1 Lumber: Stud Grade Materials, meeting the following requirements:

- .1 Maximum moisture content at time of installation; 8%.
- .2 Maximum moisture content when used for attachment of drywall; 8%.
- .3 Conforming to CAN/CSA-O141 & NLGA Rules.
- .4 Meeting requirements of the Building Code.
- .5 Consisting of species group D (SPF); Stud (No. 3) Grade or better and having the following minimum properties:
 - .1 Sizes: 38 mm or 89 mm wide by maximum 140 mm depth as noted on drawings.
 - .2 Bending at extreme fibre (F_b): 7.0 MPa
 - .3 Longitudinal shear (F_v): 1.0 MPa
 - .4 Compression parallel to grain (F_c): 7.0 MPa
 - .5 Compression perpendicular to grain (F_{cp}): 5.3 MPa
 - .6 Tension parallel to grain (F_t): 3.2 MPa
 - .7 Modulus of elasticity (E/E_{05}): 9000/5500 MPa
 - .8 Finger jointed material will not be acceptable without written acceptance from the Consultant.

2.3 Sheathing Materials

.1 Sheathing: Plywood panels to CSA O325, thickness as indicated on drawings. OSB is not permitted without written consent from Consultant.

2.4 Larson Truss

.1 280 mm deep Larsen truss @ 600 o.c.; inner chord 38 x 63; 13 x 305 x 305 mm plywood gussets @ 1200 o.c. outer chord 38 x 63. Refer to structural Drawings for fastening details.

2.5 Pressure Preservative treated Materials

.1 Pressure Preservative Treated Lumber: Lumber graded and stamped in accordance with applicable grading rules and standards of associations or agencies approved to grade lumber by Canadian Lumber Standards Accreditation Board in accordance with CAN/CSA O80.20M.

- .1 Species: Pine or Spruce-Pine
- .2 Grade: No.2 or better structural posts and lumber, pieces may be grade stamped or shipment certified by letter of compliance.
- .3 Grading authority: NLGA, paragraph 131CC
- .4 Material having twisted grain or structural defects affecting integrity of lumber will not be acceptable for this project.
- .5 Use only material with radius edges, minimum 6 mm.
- .6 Kiln dry lumber materials to 8% moisture content or less.

.2 Pressure Preservative Treated Plywood: Treated in accordance with CAN/CSA O80.9M using water-borne preservative to obtain minimum net retention of 4 kg/m³ of wood. Plywood or laminated materials shall be manufactured with exterior grade adhesives. After treatment, plywood shall be kiln dried to moisture content of 8% or less.

2.6 Pressure Fire Retardant Treated Materials

.1 Treat by pressure impregnation with fire-retardant chemicals in accordance with CAN/CSA O80.9M, CAN/CSA O80.20M and CAN/CSA O80.27M to provide classification for flame spread of not more than 25, smoke developed of not more than 75 in accordance with CAN4 S102.

- .2 All fire retardant wood must comply with the requirements in AWPA Standard C20 for lumber and C27 for plywood.
 - .1 AWPA C20: Structural Lumber, Fire-Retardant Pressure Treatment, lumber materials shall only be of species listed. After treatment, lumber 50 mm or less in thickness shall be kiln dried to moisture content of 8% or less. (withdrawn)
 - .2 AWPA C27: Plywood, Fire-Retardant Pressure Treatment, plywood or laminated materials shall be manufactured with exterior grade adhesives. After treatment, plywood shall be kiln dried to moisture content of 8% or less.(withdrawn)
 - .3 AWPA M4, Standard for the Care of Preservative-Treated Wood Products
 - .4 AWPA P17, Fire Retardant Formulations
 - .5 All species to comply with CAN4 S102 for surface-burning characteristics and shall bear identification showing classification and type of fire retardant.
 - .3 Each piece or bundle of fire-retardant treated material or panel to bear ULC inspection label or stamp attesting to FRS rating indicating flame spread, smoke developed, and fuel contributed classification meeting AWPA standard C20 and C27 for Type A Use.
 - .4 Fire retardant chemicals used to treat lumber must comply with FR-1 of AWPA Standard P17 and shall be free of halogens, sulphates and ammonium phosphate.
 - .5 Carbon steel, galvanized steel, aluminum, copper and red brass in contact with the fire retardant treated wood must exhibit corrosion rates less than one mil per year.
 - .6 Acceptable materials: Plywood and lumber materials treated by licensed applicators with fire retardant materials from the following:
 - .1 Hickson Corporation – Dricon FRTW,
 - .2 Hoover Treated Wood Preservers Inc. – Pyro-Guard,
 - .3 Chemical Specialties Inc. – D-Blaze.
 - .7 Surface applied fire retardant treatments are not acceptable for structural applications.
- 2.7 Metal Framing Connectors and Hangers
- .1 Fabricated zinc coated steel products tested or designed in accordance with CSA O86.1 and CSA S16.1. Types and products as indicated on drawings.
 - .2 Acceptable materials: Simpson Strong-Tie Company Inc.
- 2.8 Miscellaneous Materials
- .1 Nails: To CSA B111, hot dipped galvanized for exterior work and pressure preservative or fire retardant treated materials.
 - .2 Surface Applied Wood Preservative:
 - .1 Containing minimum 5% clear pentachlorophenol in accordance with CAN/CSA-O80.
 - .2 Apply minimum of 2 coats applied in accordance with manufacturers written instructions.
 - .3 Acceptable materials: Osrose-Pentox Inc.
 - .3 Screws for Fastening to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
 - .4 Rough Hardware (bolts, nuts, washers, etc.): Hot dip galvanized in conformity to ASTM A123 or Grade A low carbon steel, conforming to ASTM A307.
 - .5 Adhesive: Toxicity/IEQ: Comply with applicable regulations regarding toxic and hazardous materials, GS-36 for Commercial Adhesive, [South Coast Air Quality Management District Rule 1168] [Bay Area AQMD Reg. 8, Rule 51 for containers larger than 450 mL and with California Air Resources Board (CARB) for containers 450 mL or less], and as specified.
 - .6 Sealant: non-hardening butyl sealant as specified in Section 07 92 00.

3. EXECUTION

3.1 Rough Carpentry Work

- .1 Accurately frame and properly assemble rough carpentry work. Include all necessary nails or other connectors.

3.2 Fastenings and Rough Hardware

- .1 Unless indicated otherwise, fasten to hollow masonry units with toggle bolts; to solid masonry or concrete surfaces with expansion shields and bolts.
- .2 Where screws are required use lead or inorganic fibre plugs. Wood or organic plugs not permitted.
- .3 Powder-actuated fasteners may not be used.
- .4 Provide all rough hardware such as nails, bolts, nuts, washers, screws, clips and strap metal.

3.3 Blocks, Plates, Strapping and Furring

- .1 Install wood plates where indicated. Erect plumb and true. Rigidly support and securely anchor to masonry, concrete, and metal stud framing, as required.
- .2 Provide and install wood strapping or furring indicated on Drawings or as required.
- .3 Strapping: Shimmed out plumb, square and true to line. Use 19 mm x 64 mm at 406 mm ^O/c, unless indicated otherwise.
- .4 Furring: As indicated.
- .5 Install at least one row of solid blocking to wood stud walls not more than 2440 mm high, two rows if over 2440 mm high.
- .6 Install blocking behind all sheathing and wallboard joints, and where required for items to be fixed to walls.
- .7 Blocking in steel stud, non-combustible construction shall be pressure fire retardant treated as required to maintain fire ratings.

3.4 Roof Framing, Parapets, Cant Strips and Plates

- .1 Wood exposed to weather and water shall be pressure preservative treated. Wood in contact with roofing membranes shall not be pressure preservative treated.
- .2 Construct wooden roof curbs around openings in the roof for all penetrations except drains or as otherwise detailed. Curbs to be of height that will provide a minimum projection of 200 mm above the roof membrane. Ensure base for curb is same thickness as insulation.
- .3 Form sloped tops to all wood parapet plates and wood upstands more than 38 mm wide to roofs that receive metal flashings. Tops shall slope not less than 1 in 12. If details are at variance notify the Consultant prior to construction for further instructions.
- .4 Provide continuous wood backing for flashings.
- .5 Provide solid wood or plywood sheathing and backing, to receive membrane and metal flashings, all to roofer's requirements conforming to ARCA Manual. Fasten plywood sheathing securely to the walls of parapets with mechanical fasteners, nails will not be acceptable.
- .6 Construct framing and blocking for membrane control joints generally as detailed, conforming to the ARCA Manual.

- 3.5 Miscellaneous
- .1 Install plywood shims at window openings.
- 3.6 Exterior Carpentry Work
- .1 Construct exterior work using galvanized nails, screws or bolts. Bolts, nuts and washers shall be hot dip galvanized.
- .2 Plane all sides and backs; sand exposed faces and surfaces, round all edges to prevent checking of edges.
- .3 Countersink bolts and washers, fill holes with matching wood plugs.
- .4 Apply two liberal coats of clear surface applied wood preservative, allowing the first coat to soak in completely prior to applying second coat in accordance with manufacturers instructions.
- 3.7 Pressure Preservative Treated Wood Installation
- .1 Comply with AWWPA M4.
- .2 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation. Allow first coating to fully soak into grain before applying second coating in accordance with manufacturer's instructions.
- .3 Remove with fine sandpaper, chemical deposits on treated wood to receive applied finish.
- .4 Use only hot-dipped galvanized, corrosion resistant nail or screw fasteners. Staples are not acceptable for installation of preservative treated materials.
- .5 Use water-borne preservative treated wood for:
- .1 Wood in contact with masonry or concrete,
- .2 Wood within 450 mm of grade,
- .3 Wood decking and fence boards,
- .4 Wood in contact with flashings
- .5 Wood in contact with waterproofing membranes, confirm compatibility with membrane manufacturer prior to application.
- .6 Use oil-borne preservative treated wood for:
- .1 Wood in contact with the ground,
- .2 Wood in contact with freshwater,
- .3 Landscaping timbers,
- .4 Retaining walls,
- .5 Piers or docks,
- .6 Pilings,
- .7 Bases of utility poles,
- .8 Bases of fence posts.
- 3.8 Pressure Fire retardant treated wood Installation
- .1 Field Cuts:
- .1 Do not rip, mill or conduct extensive surfacing of fire retardant treated lumber, label will be voided.
- .2 Only end cuts, drilling holes and joining cuts are permitted.
- .3 All cuts on plywood will be considered end cuts.
- .4 Fire-retardant lumber and plywood can be given a light sanding for cosmetic cleaning after treatment.
- .5 Pre-cut to the greatest extent possible before treating.

- .2 Fire retardant treated plywood used in structural applications shall be graded or span-rated material.
- .3 Use only hot-dipped galvanized, corrosion resistant nail or screw fasteners. Staples are not acceptable for installation of fire resistant treated materials.
- .4 Where humidity conditions are such that moisture may condense between hardware and treated wood, hardware shall be back-primed with a corrosive-inhibitive paint.
- .5 Back-prime at contact points and fasteners to prevent electrolysis when fire retardant framing members are used in metal buildings.

3.9 Telecommunications and Data Panel Boards

- .1 Install 19 mm fir plywood boards on all walls in telephone and data rooms receiving wiring and equipment; minimum 1220 mm x 2440 mm panels on periphery walls over 300 mm wide, mounted 150 mm off of finished floor; coordinate installation and locations with Electrical.
- .2 Paint panels with 2 coats of light coloured fire retardant intumescent paint finish; coat all sides of panels (back, front and sides) to meet the intent of fire rated panel requirements listed in CSA T530 and ANSI/TIA/EIA 569-B requirements.

3.10 Electrical Boxes

- .1 Seal electrical switch and outlet device boxes that penetrate vapour retarder as follows:
 - .1 Install moulded vapour retarder box.
 - .2 Apply sealant to seal edges of flange to sheet vapour retarder. Install sealant at wiring penetrations through vapour retarder box.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Wood decking.

1.2 RELATED REQUIREMENTS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 06 18 00 – Glue Laminated Construction
- .3 Section 09 91 00 - Painting: Field finishing.

1.3 REFERENCE STANDARDS

- .1 National Building Code of Canada 2020
- .2 STD 117:2020 Standard specification for structural glued laminated timber of softwood species
- .3 STD 200:2009 Manufacturing quality control systems manual
- .4 STD A190.1:2007 Structural glued laminated timber
- .5 ASTM D2559-12a(2018) Standard specification for adhesives for bonded structural wood products for use under exterior exposure conditions
- .6 CSA O86 Engineering design in wood
- .7 CAN/CSA O122-16 Structural glued-laminated timber
- .8 STD O177-23 Qualification code for manufacturers of structural glued-laminated timber
- .9 STD O112 SERIES-M1977 CSA Standards for wood adhesives
- .10 STD O121-17 Douglas fir plywood
- .11 CSA O141:23 Softwood lumber
- .12 STD O151-17 Canadian softwood plywood
- .13 CSA O153:19 Poplar plywood
- .14 CSA O325:21 Construction sheathing (adopted NIST PS 2-18, with Canadian deviations)
- .15 Standard grading rules for Canadian lumber
- .16 ULC-FR-17 - Fire Resistance Directory (2017 Edition).

1.4 ACTION SUBMITTALS

- .1 Section 01 00 10: General Requirements.
- .2 Product Data:
 - .1 Provide technical data on adhesive materials.
- .3 Samples of Exposed To View Wood Deck: Submit two (2) samples, 0.36m² in size illustrating wood grain, stain, and finish.

1.5 INFORMATIONAL SUBMITTALS

- .1 Section 01 00 10: General Requirements.
- .2 Submittals:
 - .1 Submit shop drawings indicating wood thickness, grade, size, layout pattern, stain and finish.

1.6 CLOSEOUT SUBMITTALS

- .1 Section 01 00 10: General Requirements.

1.7 QUALITY ASSURANCE

- .1 Perform Work in accordance with the following agencies:
 - .1 Lumber Grading Agency: Certified by NLGA Grading Rules.
 - .2 Plywood Grading Agency: Certified by CANPLY.
- .2 In lieu of grade stamping exposed to view lumber and plywood, submit manufacturer's certificate certifying that Products conform to specified requirements.
- .3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.
- .4 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and approved by the manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Section 01 00 10: General Requirements.

Part 2 Products

2.1 MATERIALS

- .1 Dimension Lumber: CSA-O141, softwood lumber unless indicated otherwise, S4S, maximum moisture content 15%, Finger jointed lumber not acceptable. Standard Grading Rules for Lumber. NLGA Grading Rules.
- .1 Lumber select grade, species: spruce, nominal board size 38 x 141 mm, single tongue and groove, face surface "Veed" one side, placed in Controlled Random Pattern per CSA O86
- .2 Decking lengths: 2.4 to 6 m or longer with a minimum of 90% planks exceeding 3 m. Square end trimmed. 45% of quantity supplied shall be 5 m and longer. For single spans shorter than 3 m use decking of same length as span.
- .3 Controlled Random: Decking continuous for three or more spans. End joints staggered in adjacent planks not less than 610 mm. Joints in same general line separated by at least two intervening courses. End joints in first half of end spans avoided.

2.2 ACCESSORIES

- .1 Fasteners and Anchors:
- .1 Nails : hot dipped galvanized finish; sizes as recommended in CAN/CSA O86
- .1 Length:
- .1 3.66mm diameter x 76mm long minimum.
- .2 Sufficient length to achieve full penetration of decking substrate.
- .3 Nails shall penetrate 38 mm into supporting members.
- .4 Fastener pattern as shown on drawings
- Galvanized Coating for Exterior Work: Hot dip galvanized to ASTM A153/A153M.
- .2 Adhesive: Waterproof, air cure type, cartridge dispensed.
- .1 Product to be submitted to consultant for review.
- .3 Sealer: Manufacturers standard, compatible with topcoats.

2.2 FABRICATION

- .1 Fabricate units in accordance with the drawings and specifications and the reviewed shop drawings.
- .2 Verify dimensions of existing work prior to commencing fabrication.
- .3 Verify all dimensions and conditions prior to commencing fabrication.
- .4 Mark all members for identification. Straight beams to have their top surface clearly marked.

Part 3 Execution

3.1 EXAMINATION

- .1 Section 01 00 10: General Requirements.
- .2 Verify that support framing is ready to receive decking.

3.2 INSTALLATION - LUMBER DECKING

- .1 Install decking in accordance with CAN/CSA-O86, controlled random pattern.
- .2 Install decking perpendicular to framing members. On sloped surfaces, lay decking with tongue upward.
- .3 Fit butt end deck joints occurring between support members with metal splines to maintain tight, aligned joints.
- .4 Engage decking tongue and groove edges.
- .5 Cut decking to accommodate roof drain and flange.

.6 Stagger end joints in adjacent planks minimum of 0.61 m. Separate joints in same area by at least two intervening courses. Avoid joints in first fifth of end spans. Minimize joints in middle third of span.

.7 Nailing- as shown on drawings.

3.3 ERECTION TOLERANCES

.1 Section 01 00 10: General Requirements.

3.4 FIELD QUALITY CONTROL

.1 Testing:

.1 Testing moisture content of delivered material will be performed by testing laboratory designated by the Owner.

.2 Owner will pay for costs of testing in accordance with Section 01 00 10: General Requirements.

.3 Testing moisture content of delivered material will be by testing laboratory designated by Departmental Representative by moisture meter with adjustments for species and temperature.

3.2 CLEANING

.1 Remove tool marks, bruises, and scratches.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Glue laminated wood.
- .2 Hardware and attachment brackets.

1.2 RELATED REQUIREMENTS

- .1 Section 03 30 00 Cast-in-Place Concrete.
- .2 Section 05 12 23 Structural Steel for Buildings
- .3 Section 05 31 00 Steel Decking
- .4 Section 05 50 00 Metal Fabrications
- .5 Section 06 15 00 Wood Decking.
- .6 Section 09 91 00 Painting: Field finishing.

1.3 PRICE AND PAYMENT PROCEDURES

- .1 Payment for the work of this section shall be on a lump sum basis as tendered which shall be full compensation for all labour, materials, and equipment necessary to complete the work, including all subsidiary and incidental items thereto for which separate payment is not elsewhere provided.

1.4 REFERENCE STANDARDS

- .1 STD 117:2020 Standard specification for structural glued laminated timber of softwood species
- .2 STD 200:2009 Manufacturing quality control systems manual
- .3 STD A190.1:2022 Structural glued laminated timber
- .4 ASTM A36/A36M-19 Standard specification for carbon structural steel
- .5 ASTM A123/A123M-17 Standard specification for zinc (hot-dip galvanized) coatings on iron and steel products
- .6 ASTM A153/A153M-23 Standard specification for zinc coating (hot-dip) on iron and steel hardware
- .7 ASTM F3125/F3125M-21 Standard specification for high strength structural bolts and assemblies, steel and alloy steel, heat treated, inch dimensions 120 ksi and 150 ksi minimum tensile strength, and metric dimensions 830 MPa and 1040 MPa minimum tensile strength
- .8 ASTM D2559-12a(2018) Standard specification for adhesives for bonded structural wood products for use under exterior exposure conditions
- .9 CSA O80 SERIES:21 Wood preservation
 - .1 CSA-O80.1-15 - Specification for Treated Wood.
 - .2 CSA-O80.3-15 - Preservative Formulations.
- .10 CSA O86:19 Engineering design in wood
- .11 CAN/CSA O122-16 (R2021) Structural glued-laminated timber
- .12 STD O177-23 Qualification code for manufacturers of structural glued-laminated timber
- .13 CSA S16: 24Design of steel structures
- .14 CSA W47.1:19 Certification of companies for fusion welding of steel
- .15 STD W59.2-24 Welded aluminum construction
- .16 ULC-FR-17 - Fire Resistance Directory (2017 Edition).
- .17 Warnock Hersey - Certification Listings.

1.5 ACTION SUBMITTALS

- .1 Section 01 00 10: General Requirements.
- .2 Product Data: Provide technical data on wood preservative materials, application technique and resultant performance information.
- .3 Shop Drawings: Indicate framing system, sizes and spacing of members, loads and cambers, bearing and anchor details, bridging and bracing, framed openings.

1.6 INFORMATIONAL SUBMITTALS

- .1 Section 01 00 10: General Requirements.
- .2 Submit design calculations.

1.7 CLOSEOUT SUBMITTALS

- .1 Section 01 00 10: General Requirements.

1.8 QUALITY ASSURANCE

- .1 Perform welding Work in accordance with CSA-W59.
- .2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience and certified in a plant certified by Canadian Standards Association Administrative Board as meeting the requirements of CAN/CSA-O177.
- .3 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and approved by the manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- .1 Section 01 00 10: General Requirements.
- .2 Deliver glue-laminated members to the site, in consultation with the manufacturer, three months prior to erection for gradual moisture content adjustment. Deliver all members to the site wrapped for protection.
- .3 Protection is to remain in place until immediately prior to installation of framing.

Part 2 Products

2.1 MATERIALS

- .1 Dimension Lumber: CSA-O112, Douglas Fir-Larch, S4S, maximum moisture content 12% before fabrication.
- .2 Adhesive: to CSA-O112 Series, to grade of service required in accordance with CAN/CSA-O122.
- .3 Sealer for glued-laminated members: penetrating type, clear, non-yellowing liquid.

2.5 ACCESSORIES

- .1 Fastenings:
 - .1 Shear plate connections:
 - .1 Pressed steel type: hot rolled carbon steel, SAE 1010, meeting requirements of SAE handbook.
 - .2 Malleable iron type: to ASTM A47/A47M, grade 350.
 - .2 Bolts: to ASTM A307 or ASTM A325.
 - .3 Side plates: to CAN/CSA-G40.20/G40.21 or ASTM A36.
 - .4 Drift pins: to ASTM A307.
 - .5 Glued-laminated rivets: hot dip galvanized to CAN/CSA-G40.20/G40.21.
 - .6 Truss plates: light gauge galvanized sheet steel to ASTM A653, grade A, yield point 230MPa.
- .2 Shop coat primer for steel connections: To conform to CISC/CPMA 1-73a, Colour to be Grey.
- .3 Galvanizing: to CAN/CSA-G164, hot dipped, minimum zinc coating of 600 g/m².

2.7 FABRICATION

- .1 Fabricate members to stress grade and species as follows:
 - .1 Bending Members: 24f-E Douglas Fir-Larch for simple span member and 24f-EX Douglas Fir-Larch for continuous or cantilevered members.
 - .2 Compression Members: 24F-EX Douglas Fir-Larch.
 - .3 Tension Members: 18t-E Douglas Fir-Larch.
- .2 Appearance grade:
 - .1 Quality
- .3 Shop applied sealers: Two coats of polyurethane one-component to end grain. One coat of polyurethane one-component to remainder of members.

- .4 Do not apply sealer to areas which are to receive stained finish or preservative treatment.
- .5 Notify Consultant a minimum of 24 hours prior to fabricating any glue-laminated units to allow for inspection.
- .6 Fabricate units in accordance with CAN/CSA-O122, the drawings and specifications and the reviewed shop drawings.
- .7 Verify dimensions of existing work prior to commencing fabrication.
- .8 Verify all dimensions and conditions prior to commencing fabrication.
- .9 Camber for Beams to the radius noted on drawings.
- .10 Tag and mark members and connections as identified on the shop drawings. Affix grade labels. Locate marks and labels at locations concealed after installation.
- .11 Design connections to CAN/CSA-O86 and CAN/CSA-S16 unless specifically detailed, to resist shears, moments, and forces indicated.
 - .1 Fabricate in accordance with CAN/CSA-S16.
- .12 Prime paint connections after fabrication to CAN/CSA-S16.
- .13 Where exterior service grade material is specified, galvanize all exterior connections and connections subject to high moisture content.
- .14 All exterior bolts and bolts used for connections where exterior service grade material is specified to be cadmium plated or galvanized.
- .19 Field Finishing of Members: As specified in Section 09 91 00.

Part 3 Execution

3.1 EXAMINATION

- .1 Section 01 00 10: General Requirements.
- .2 Verify that supports are ready to receive units.
- .3 Verify sufficient end bearing area.

3.2 ERECTION

- .1 Notify Consultant a minimum of 48 hours prior to installing any glue-laminated structural units to allow for inspection.
- .2 Prior to site erection, examine all site conditions relating to this section of work to ensure that they are acceptable for a satisfactory installation. Report any discrepancies to the Consultant.
- .3 Ensure that all structural timbers and connections will sustain any erection loadings that may occur with an adequate safety factor. All temporary erection bracing is to remain in place until framing is connected to the permanent lateral stability elements.
- .4 Lift members using protective straps to prevent visible damage.
- .5 Use pads or blocking between slings and members when handling.
- .6 Set structural members level and plumb, in correct positions or sloped where indicated.
- .7 Provide temporary bracing and anchorage to hold members in place until permanently secured.
- .8 Fit members together accurately without trimming, cutting, or other unauthorized modification.
- .9 Swab and seal the interior wood surfaces of field drilled holes in members with primer.
- .10 Do not cut, trim, or drill members in any manner that will affect the strength or safety of members or without the written approval of the manufacturer and the Consultant. If approved, preservative treat cut ends.
- .11 Protect protective sealer from damage before erection.
- .12 Touch up damaged areas on site with specified sealer.

3.3 ERECTION TOLERANCES

- .1 Section 01 00 10: General Requirements.

3.4 CERTIFICATION

- .1 At the completion of work, certify all connections and components fabricated and erected by the manufacturer under the seal and signature of the Contractor's professional Consultant responsible for this work.
- .2 Certify that all connections and welded components are capable of supporting all the loads and forces specified in the contract drawings.
- .3 Certify that all designed components are fabricated and erected in accordance with the reviewed shop drawings.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide shop fabricated architectural woodwork in accordance with requirements of the Contract Documents.

1.2 References

- .1 Architectural Woodwork Standards referenced in this Section form the basis of the quality standards for materials and installation; materials standards and grading authorities referenced in this Section and listed in the Architectural Woodwork Standard are applicable where specifically referenced and are considered to form a part of and be applicable to this Section.
- .2 Architectural Woodwork Manufacturers Association of Canada (AWMAC):
- .1 NAAWS 4th Edition
 - .2 AWMAC Architectural Woodwork Standards
 - .3 AWMAC Guarantee and Inspection Service Guide and Manual
- .3 ASTM International (ASTM):
- .1 ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
 - .2 ASTM C920, Standard Specification for Elastomeric Joint Sealants
 - .3 ASTM D1037, Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
 - .4 ASTM D3574, Standard Test Methods for Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams
 - .5 ASTM D5672/D5672M, Standard Test Method for Testing Flexible Cellular Materials Measurement of Indentation Force Deflection Using a 25-mm [1-in.] Deflection Technique
- .4 American National Standards Institute (ANSI):
- .1 ANSI A135.4, Basic Hardboard
 - .2 ANSI A208.1, Particleboard
 - .3 ANSI A208.2, Medium Density Fiberboard (MDF) for Interior Applications
- .5 CSA Group (CSA):
- .1 CAN/CSA A172, High Pressure Paper Base, Decorative Laminates
 - .2 CAN/CSA O121, Douglas Fir Plywood
 - .3 CAN/CSA O141, Softwood Lumber
 - .4 CAN/CSA O151, Canadian Softwood Plywood
- .6 Underwriters Laboratories Canada (ULC):
- .1 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
- .7 National Electrical Manufacturers Association (NEMA):
- .1 NEMA LD 3, High Pressure Decorative Laminates

1.3 Administrative Requirements

- .1 Coordination: Architectural woodwork Trade Contractor and the Construction Manager are jointly responsible for the following items:

- .1 Coordinate delivery of casework components at a time when building and storage areas are sufficiently dry so that the casework will not be damaged by excessive changes in moisture content.
 - .2 Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that interior casework can be supported and installed including; but not limited to, the following:
 - .1 Metal support brackets and fittings that are part of building structure
 - .2 Plumbing, electrical fixtures and telephone equipment
- 1.4 Submittals
- .1 Product Data: Submit for Consultant's action. Furnish each type of product including hardware and panel accessories, adhesive materials, laminates, veneers and accessories to be used in the Work.
 - .1 Submit product data for each type of product indicated including, but not limited to, the following:
 - .1 Cabinet hardware and accessories
 - .2 Finishing materials and processes
 - .3 Manufactured hardboard, medium density fibreboard
 - .4 High pressure decorative laminate and adhesive for bonding decorative laminate
 - .5 Low pressure decorative laminate
 - .6 Solid surfacing material
 - .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings indicating location of each item referenced to actual site dimensions, dimensioned plans and elevations, large scale detailed and thickness of materials, attachment devices, scribe strip locations, locations of exposed fastenings and other components as applicable to work of this section.
 - .3 Samples: Submit for Consultant's action. Submit two (2) samples prior to fabrication of casework as follows; accepted samples will form the standard of acceptance for the remainder of the work:
 - .1 High Pressure Decorative Laminate Clad Panel Products: Laid-up on specified core material, 300 mm x 300 mm for each type, colour, pattern, and surface finish.
 - .2 Low Pressure Decorative Overlay (Melamine) Surfaced Panel Products: Laid-up on specified core material, 300 mm x 300 mm for each type, colour, pattern, and surface finish.
 - .3 Exposed Cabinet Fasteners, Hardware and Accessories: One unit for each type.
 - .4 Certificates: Submit for Consultant's information. Furnish certified test reports.
 - .5 Project Closeout Submissions: Submit for Consultant's action. Submit three (3) copies of Project Record Sheet identifying the following:
 - .1 Project title and address
 - .2 Owner, Consultant, Construction Manager, and casework Trade Contractor
 - .3 Materials and finishes used for casework and whether shop finished or site finished and by whom
 - .4 Type and source of cabinet hardware and any specialty items used under casework
 - .6 Quality Control Submittals: Submit for Consultant's action. Provide proof of qualifications:
 - .1 Project Quality Standard: Architectural Woodwork Standard (AWS) published by the Architectural Woodwork Manufacturers Association of Canada, together with authorized additions and amendments will be used as a reference standard and forms part of this project specification, and as follows:
 - .1 Modifications made in this Section that change the requirements of the AWS will govern in case of conflict.
 - .2 References to Economy, Custom or Premium Grade in this specification are as defined in the AWS; any item not given a specific quality grade will be Custom Grade as defined in the AWS.
 - .3 Provide a copy of the AWS for reference purposes on the job site.

- .4 References in this specification to part and item numbers mean those parts and items contained within the AWS.

1.5 Delivery Storage and Handling

- .1 Delivery and Acceptance Requirements: Deliver woodwork materials only when building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period, as follows:
- .1 Deliver, store, and handle casework in accordance with AWS Section 2 Care and Storage.
 - .2 Delivered materials that are damaged in any way or do not comply with these specifications will be rejected by the Consultant; remove rejected materials from job site and replace with acceptable materials.
 - .3 AWMAC guarantee of 2 years is required.

1.6 Site Conditions

- .1 Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on Shop Drawings where casework is indicated to fit walls and other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work; locate concealed framing, blocking, and reinforcements that support woodwork by site measurements before being enclosed and indicate measurements on Shop Drawings.
- .2 Established Dimensions: Establish dimensions and proceed with fabricating casework without confirmed site measurements where site measurements cannot be made without delaying the Work; coordinate with the construction to ensure that actual dimensions correspond to established dimensions; allow for trimming and fitting.
- .3 Ambient Conditions: Maintain area or room in which casework is being installed at a uniform temperature and humidity for 24 hours prior to, during and after installation in accordance with AWS for relative humidity and moisture content; provide additional lighting to maintain a minimum of 430 lx on surfaces and areas where casework is being installed.

1.7 Maintenance

- .1 Maintenance Manuals: Submit for Owner's documentation. Furnish complete manuals describing the materials, and procedures to be followed in cleaning and maintaining the Work. Include manufacturers' brochures and lists describing actual materials used in the Work, including metal alloys, finishes, hardware and other major components

2. PRODUCTS

2.1 Materials

- .1 Use clean stock for each type of woodwork and quality grade specified in accordance with AWS.
- .2 Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 8% moisture content.
- .3 Anchors: Select material, type, size, and finish required for each substrate for secure anchorage:
- .1 Provide nonferrous metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.
 - .2 Provide toothed steel or lead expansion sleeves for drilled-in-place anchors.
- .4 Panel Materials: Provide panel materials meeting requirements for moisture content and Custom Grade in accordance with AWS Section 4, paint grade tongue and groove paneling as indicated on Drawings.

- .1 Medium Density Fibreboard (MDF): Meeting ANSI A208.2, Premium Grade for interior use, minimum 750 kg/m³ density; formaldehyde emissions shall be 0.30 ppm or less per 0.424m²/m³ of room volume. **[MDF is not permitted for use in wet areas.]**
 - .2 Fire Retardant Treatment for MDF: Treat MDF with opaque coating including primer, treatment and overcoats as recommended by coating manufacturer to provide a ULC Class A fire resistant finish.
 - .3 Softwood Plywood: Meeting CSA O121 or CSA O151, cross-banded, sanded G2S, thickness as indicated.
 - .4 Hardboard: Meeting CAP/ANSI A135.4, minimum density 500 kg/m³, tempered hardboard (Masonite), 6 mm nominal thickness unless noted otherwise, one face smooth finish; colour as selected by Consultant from manufacturer's full range.
 - .5 Decorative Laminate Finishes: Grades and applications in accordance with AWS Section 4, and as follows:
 - .1 High Pressure Decorative Laminate (HPDL): Meeting ANSI/NEMA LD3 composed of phenolic resin impregnated Kraft paper filler stock for Class 1 Decorative Laminate of Grade required by woodwork quality standard; and as follows:
 - .1 Self Edging Work: General Purpose Grade, HGS standard duty.
 - .2 Liner Sheet Work: Same as for self edging work.
 - .3 Backing Sheet Work: BKL backing material, thickness as recommended by manufacturer to prevent warpage of surfaces, sanded on one side; furniture finish.
 - .4 Colours: indicated as PL-1, PL-2, PL-3 in Section 09 06 06.
 - .2 Low Pressure Decorative Laminate (LPDL): minimum 0.5 mm low pressure decorative laminate (melamine) overlay, decorative paper, and phenolic resin impregnated kraft paper with fibre reinforcing inner layers; Colour and texture as selected by Consultant.
 - .1 Self Edging Work: General Purpose Grade, HGS standard duty.
 - .2 Basis-of-Design Materials: Panolam Industries International Inc.
 - .6 Solid Surfacing: as indicated in Section 06 61 16.
 - .7 Wood Slats (WD-1) as follows:
 - .1 Wood Species: White Oak
 - .2 Product: Solid Lumber
 - .3 Dimensions: 50mm x 12mm
 - .4 Grade: II (pieces shall be well-matched for colour and grain)
 - .5 Stain: To match WWP-2
 - .6 Finish: Sanded smooth, sealed to maintain colour, and finished with a water-based clear coat: Sansin water-based clear top coat.
 - .7 Note: Millworker to provide finish sample to designer prior to fabrication.
- 2.2 Accessories
- .1 Casework Hardware: Provide cabinet hardware described in this Section in quantity required, with necessary screws, bolts, washers for complete installation.
 - .1 Fasteners:
 - .1 Draw Bolt Fasteners: Mitre butt joint fastener, adjustable and requiring no special tools for installation, galvanized.
 - .2 Non-exposed Fasteners: Fabricators choice consistent with quality level specified.
 - .2 Pulls: DP-1 as follows:
 - .1 Manufacturer: Richelieu
 - .2 Product #: 30576195, Modern Steel Pull 305
 - .3 Size: 3"
 - .4 Color/Material: Metal
 - .5 Finish: Brushed Nickel

- .3 Drawer Slides: Following list of drawer slides is provided to indicate general conformance requirements only; notify the Consultant where drawer width, height or intended use differs from that indicated in the general descriptions and the requirements of the manufacturer; coordinate sample submittals before ordering materials:
 - .1 Drawers: Full extension, length to suit drawer box; 406 mm maximum drawer width, 30 kg capacity, bottom mounting with positive stop, self closing, hold-in detent and silencer features, [black] [zinc] finish:
 - Basis-of-Design: Blum Tandem
 - .2 Typical Cabinet Doors: Concealed, euro-style hinge with cover caps; fully adjustable for overlay, depth, height and closing force; opening angle of 110°; self-closing, soft close feature; nickel plated steel construction; overlay and half overlay mounting, size and profile to suit cabinet construction:
 - Acceptable Materials:
 - Julius Blum Canada Ltd., clip top
 - Grass
 - .4 Shelf Rests:
 - .1 Surface mounted pilaster with clips: Nickel plated, surface mounted steel standards mounted 150 mm from top & bottom, one support for each 305 mm of standard:
 - Acceptable Materials:
 - Knappe & Vogt 255/256
 - Richelieu 2552G/CP2562G
 - .5 Miscellaneous Items:
 - .1 Coat Rod: Closets, 28 mm outside diameter x 2.8 mm thick chrome tube complete with closed end chrome flanges
 - Basis-of-Design Materials: Knappe & Vogt 734/770.
 - .2 Sealant: 1 part silicone to ASTM C920, non-staining, mould and mildew resistant, colour: as selected by Consultant, refer to Section 07 92 00, type 2.
 - .3 Steel Supports: Refer to Section 05 50 00 and as detailed.
 - .4 Hardware: Bolts, nuts, washers, screws, etc., hot dip heavy zinc-coated.
- 2.3 Casework Fabrication
- .1 Fabricate casework in accordance with requirements of Section 10 of AWS as applicable and as modified by this Section and Drawings.
 - .2 Casework for High Pressure Laminate Finish:
 - .1 AWMAC Quality Grade Custom.
 - .2 Exposed Exterior Parts:
 - .1 Core: Particleboard
 - .2 Finish: HPDL.
 - .3 Exposed Interior Parts:
 - .1 Core: Particleboard
 - .2 Finish: HPDL.
 - .4 Semi-Exposed Parts:
 - .1 Core: Particleboard
 - .2 Finish: backer grade HPDL.
 - .5 Concealed Parts:

- .1 Core: Particleboard
- .2 Finish: backer grade HPDL.
- .6 Edge Banding for Shelves: Finished on [all four (4) edges] [front exposed edge only] and as follows:
 - .1 High Pressure Decorative Laminate for HPDL Finished Surfaces: Colour to match with surface finish
- .7 Edge Banding for Doors, Drawers and False Fronts: Finished on all four (4) edges and as follows:
 - .1 High Pressure Decorative Laminate for HPDL Finished Surfaces: Colour to match with surface finish
- .8 Edge Banding Adhesive: Thermoplastic hot melt, synthetic resin suitable for applying edge banding and film overlays.
- .9 Fabricate doors and drawer fronts using flush overlay; fabricate drawers in accordance with AWS requirements for Grade indicated.
- .10 Fabricate casework in accordance with AWS requirements for frameless construction.
- .11 Edge Banding for Shelves: Finished on all four (4) edges and as follows:
 - .1 High Pressure Decorative Laminate for HPDL Finished Surfaces: Colour to match with surface finish
- .12 Edge Banding for Doors, Drawers and False Fronts: Finished on all four (4) edges and as follows:
 - .1 High Pressure Decorative Laminate for HPDL Finished Surfaces: Colour to match with surface finish
- .13 Edge Banding Adhesive: Thermoplastic hot melt, synthetic resin suitable for applying edge banding and film overlays.
- .14 Fabricate doors and drawer fronts using flush overlay; fabricate drawers in accordance with AWS requirements for Grade indicated.
- .15 Fabricate casework in accordance with AWS requirements for frameless construction.
- .3 Solid Surface: Refer to Section 06 61 16.
- .4 Construct casework using minimum core thickness for materials listed in this section; adjust thickness of shelves to allow for uniformly distributed loading of 90 kg with a concentrated load of 23 kg and length for maximum of L/144 deflection in full use:
 - .1 Assemble casework with flush butt hairline corners and joints; make cut outs for services on site during installation
 - .2 Carefully fit, cope or mitre joints and glue with no end wood visible on finished surfaces; unless specifically detailed on Drawings as decorative exposed plywood cores].
 - .3 Make blocking, framing, web frames from solid lumber
 - .4 Provide solid wood edge strips in doors and cases to receive hardware; rebate and pressure glue to core
 - .5 Cut and adapt casework to receive hardware; install finishing hardware and fittings in shop, except that fittings that may be susceptible to damage during shipping and installation may be installed after casework is installed on site
- .5 Glue, dowel, mortise, lock joint or dado casework; do not use staples; nailing and screws are acceptable; do not surface nail or screw through countertops:
 - .1 Set nail heads in finished surfaces; countersink screws and bolts; unless specifically detailed on Drawings as being exposed; fill holes with edge grain wood plugs to match colour and grain.
- 2.4 Finishing
 - .1 Factory finishing in accordance with AWS for Custom grade.

3. EXECUTION

3.1 Examination

- .1 Visit site and note state of completion within various areas in which casework is being installed; verify that surfaces are ready to receive work of this Section and that other work is finished and painted before being built-over or covered in any way by installed casework:
 - .1 Verify that areas in which casework is scheduled are finished and ready to accept work of this Section; with walls painted, ceilings finished, overhead services completed, tested and accepted.
 - .2 Starting work will be considered as acceptance of conditions.

3.2 Preparation

- .1 Confirm access is sufficient for large pieces of casework, and that they can be transported easily and safely to final installation location.
- .2 Protect adjacent finished surfaces and materials from damage by work of this Section.
- .3 Back prime casework immediately after delivery to site.

3.3 Installation

- .1 Install casework plumb, level and true to locations indicated on Drawings and in accordance with AWS.
- .2 Anchor to floor, walls or ceiling using fastening devices and hardware consistent with materials being fastened into and quality of finish, and as follows:
 - .1 Do not use wood plugs
 - .2 Do not use plastic plugs for ceilings or walls
 - .3 Provide wall cleats fastened to wall blocking as required
 - .4 Shim level and square in relation to adjoining surfaces
 - .5 Scribe accurately to adjacent work
 - .6 Provide allowance for finish flooring installation to base by related sections of work
 - .7 Set on steel support framing; coordinate fabrication requirements with Section 05 50 00
- .3 Scribe neatly and accurately to smooth snug fit with adjoining surfaces and materials to align work properly; mitre corners accurately.
- .4 Perform cutting, fitting, repairing in woodwork as required by other trades where their Work is connected to or part of this Work.
- .5 Cut out openings for mechanical and electrical fittings and fixtures; coordinate and cooperate with mechanical and electrical work and obtain required templates, cutting locations and dimensions.
- .6 Apply neat bead of sealant white between plumbing fixtures countertops and adjoining walls and casework; seal edges of cut out core material before fixtures installed with moisture resistant compound.
- .7 Install any finishing hardware shipped loose.
- .8 Install solid surface countertop to casework units; coordinate schedule and delivery requirements to meet the construction schedule.

3.4 Closeout Activities

- .1 Deficient Work: Replace, rework or refinish work that does not meet AWS requirements as directed by Consultant at no additional cost.

- .2 Adjusting: Adjust hardware and operating parts during and after installation to provide smooth and proper operation of casework components.
- .3 Cleaning: Clean casework, cabinets, countertops, shelves and fixtures, and remove marks, scratches or marring on exposed and semi-exposed surfaces after work of this Section is complete and prior to Substantial Performance for the project.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide Solid Surfacing Fabrications in accordance with requirements of Contract Documents.

1.2 References

- .1 American National Standards Institute (ANSI):
- .1 ANSI/IAPMO Z124.3, Plastic Lavatories
 - .2 ANSI/IAPMO Z124.6, Plastic Sinks
- .2 NSF International/American National Standards Institute (ANSI):
- .1 NSF/ANSI 51, Food Equipment Materials
- .3 Underwriters Laboratories Canada (ULC):
- .1 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

1.3 Submittals

- .1 Product Data: Submit for Consultant's action manufacturer's standard product data indicating product description, fabrication information and compliance with specified performance requirements.
- .2 Shop Drawings: Submit for Consultant's action shop drawings indicating dimensions, component sizes, fabrication details, attachment provisions and coordination requirements with adjacent work.
- .3 Samples: Submit for Consultant's action two (2) representative samples indicate full range of color and pattern variation.
- .4 Coordination Drawings: Submit for Consultant's action coordination drawings indicating layout of plumbing and electrical work, steel reinforcing, recessed and built-in items and wall blocking information; indicate the following:
- .1 Project specific information, drawn accurately to scale.
 - .2 Do not base coordination drawings on reproductions of the contract documents or standard printed data.
 - .3 Indicate dimensions shown on the contract drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements.
 - .4 Interference locations and sketches indicating proposed resolution; minor dimension changes and difficult installations will not be considered changes to the contract.

1.4 Project Closeout Submissions

- .1 Operation and Maintenance Data: Submit manufacturer's care and maintenance data, including repair and cleaning instructions.

1.5 Quality Assurance

- .1 Qualifications: Provide proof of qualifications when requested by Consultant:
- .1 Fabricator: Use a fabricator having a minimum of three (3) years' experience in fabrication and installation of solid surface materials and have training and certification from the manufacturer for work of similar scope and complexity as that required for the project.

1.6 Delivery, Storage and Handling

- .1 Delivery and Acceptance Requirements: Deliver components to project when areas are ready for installation.
- .2 Storage and Handling Requirements: Store components indoors in heated conditions similar to the area of installation until ready for installation; handle materials to prevent damage to finished surfaces; provide protective coverings to prevent physical damage or staining following installation until just prior to Substantial Performance for the Project.

1.7 Warranty

- .1 Manufacturer Warranty: Provide manufacturer's standard 10 year warranty against defects in materials and workmanship; including material and labour to repair or replace defective materials.

2. PRODUCTS

2.1 Materials

- .1 Solid Surfacing Sheet: Cast, nonporous, filled polymer, with through body colour meeting requirements of NEMA LD 3, and having the following nominal properties:
 - .1 Thickness: minimum 12 mm
 - .2 Surface Burning Characteristics: in accordance with CAN/ULC S102 and as follows:
 - .1 Flame Spread: Maximum 25
 - .2 Smoke Developed: Maximum 25
 - .3 Pattern and Colour: As indicated as SF-1, SF-3 in Section 09 06 06.
- .2 SF-2: Prefabricated Sinks: Cast, nonporous, filled polymer, with through body colour meeting requirements of ANSI Z124.3, ANSI Z124.6 and NEMA LD 3, and as follows:
 - .1 Mounting: Integral
 - .2 Configuration: as detailed
 - .3 Shape and Size: as detailed

2.2 Accessories

- .1 Joint Adhesive: Manufacturer's recommended adhesive designed to create chemically bonded, inconspicuous, nonporous joints.
- .2 Panel Adhesive: Manufacturer's standard neoprene-based panel adhesive meeting ANSI A136.1.
- .3 Sealant: Mildew resistant, silicone sealant, [white] colour, as specified in Section 07 92 00.
- .4 Sink Mounting Hardware: Manufacturer's recommended clips, inserts and fasteners for attachment of under mount sinks.

2.3 Fabrication

- .1 Fabricate units to maximum size capable of being safely transported and handled to place of final installation in accordance with shop drawing and manufacturer's written instructions using a fabricator certified by the manufacturer.
- .2 Fabricate and machine shapes to profiles indicated on Drawings; obtain all dimensions affecting fabrication and installation from job site before starting fabrication.
- .3 Cut, drill and shape fabrications as required to receive plumbing fittings and services, and built-in accessories, provide edge treatments, back splashes, and other details as indicated on Drawings.
- .4 Finish edges and surfaces true, level and even with inconspicuous joints between having no voids formed using manufacture's standard joint adhesive and reinforcing strips.

- .5 Make cut outs with 3 mm radius corners to prevent stress cracking.
- .6 Fabrication assemblies with tolerances as follows:
 - .1 Variation in component size: ± 3 mm.
 - .2 Location of openings: ± 3 mm from indicated location.
- .7 Match numbered components assembled on site; number items to show proper location on site; number on back using material that will not show or telegraph through finished assemblies.
- .8 Provide anchorage to receive Work of other Sections scheduled and detailed to be installed.

3. EXECUTION

3.1 Installation

- .1 Install components plumb and level, in accordance with shop drawings and manufacturers written installation requirements.
- .2 Form field joints using manufacturer's recommended adhesive, with joints inconspicuous in finished work.
- .3 Adhere under mount sinks to countertops using manufacturer's recommended adhesive and mounting hardware.
- .4 Install backsplashes and end splashes as indicated on Drawings; adhere to countertops using manufacturer's standard colour matched silicone sealant.
- .5 Coordinate plumbing connections and electrical requirements with affected Sections of work.

3.2 Protection and Cleaning

- .1 Keep components and hands clean during installation; remove adhesives, sealants and other stains as work progresses; keep components clean until Substantial Performance for the Project.
- .2 Repair or replace damaged work that cannot be repaired to match installed work at no additional cost to the Owner.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 The building envelope is comprised of the building components that control the flow of heat, light, sound, air and moisture between the variable exterior environment and the controlled interior environment.
- .2 The effective RSI values, as listed on Architectural drawings as provided by the energy modelling team, are considered the minimum requirements. Substitutions within the envelope assembly will be considered, but it remains the responsibility of the bidder to provide acceptable documentation that these minimum effective RSI values are being met.
- .3 Refer to Appendix A – Polaris Project – CD Report Submission, dated March 11, 2024, 31 pages.

1.2 Durability

- .1 Materials used in the construction of the building envelope must be suitable for the task and be able to last the design life of the building under the anticipated weather and use conditions without significant deterioration or loss of function.

1.3 Architectural

.1 Thermal Barrier

- .1 For temperature-controlled spaces, the construction will incorporate insulation materials that have a sufficient and proven capacity to retard the flow of heat between temperature controlled and uncontrolled spaces.
- .2 This material is to meet all applicable material and building codes.
- .3 This material is to be installed in a fashion as to provide as continuous a thermal envelope as possible.
- .4 Routine and regular inspection of the thermal insulation details and connections by the designer, general contractor and/or building envelope consultant are required.

.2 Vapour Diffusion Retarders

- .1 The infiltration rate must be limited to 0.6 air changes per hour at a pressure difference of 50 Pa as tested per ASTM E779 standard.
- .2 For temperature-controlled spaces, the construction will incorporate materials that have a sufficient and proven capacity to retard the flow of water vapour.
- .3 This material is to meet all applicable material and building codes
- .4 This material is to be installed in the building envelope construction in a location that does not allow for condensation to form on it.
- .5 This material is to be installed in a continuous fashion with a minimum of penetrations.
- .6 Routine and regular inspection of the constructed vapour diffusion retarder details and connections by the designer, general contractor and/or building envelope consultant are required.

.3 Air Barrier

- .1 For temperature-controlled spaces, the construction of the air barrier will incorporate materials that have a sufficient and proven capacity to block the flow of air through the building envelope.
- .2 The air barrier must be structurally supported in such a fashion to be able to resist the design wind and air pressure loads
- .3 This material is to meet all applicable material and building codes
- .4 This material is to be installed in the building envelope construction in a location that does not allow for condensation to form on it.
- .5 The air barrier must be continuous across the building envelope
- .6 Routine and regular inspection of the constructed air barrier details and connections by the designer, general contractor and/or building envelope consultant are required.

.4 Water Shed & Drainage Plane

- .1 The exterior finishes must shed a significant majority of the bulk water impinging on the exterior surfaces resulting either environmental or manmade conditions
 - .2 Collection and retention of bulk water by the exterior finish is not allowed unless adequate drainage is provided.
 - .3 The designers, contractors, and sub-contractors understand that bulk water penetration through the exterior finish may occur. Given this, an effective drainage plane or other construction must be provided to remove penetrating moisture from the building envelope. Trapped bulk water is unacceptable.
 - .4 Redundancy within the water shed and drainage plane should be incorporated where ever possible.
 - .5 Routine and regular inspection of the constructed water shed and drainage plane details and connections by the designer, general contractor and/or building envelope consultant is required.
- .5 Detailing and Connections
- .1 The building envelope details shall be designed to be constructible and repeatable by tradesman of average skill.
 - .2 The general contractor shall schedule the construction of the building envelope to ensure proper sequencing and installation of materials.
 - .3 It is impractical to expect that the designers have provided architectural drawings that show all possible connection and installation details. All parties are to be cognizant of this fact be watchful for difficult or undetailed connections.
 - .4 Building envelope connections are to be constructed to prevent the penetration of exterior bulk water into moisture susceptible constructions.
 - .5 Building envelope connections are to be constructed to provide durable performance over the design life of the building.
 - .6 Unforeseen material connections that are difficult to construct within the building envelope construction may occur. The designer and the building envelope consultant must be advised on all such matters so that the detail can be reviewed and installation methodologies confirmed. Poor installation of a difficult-to-construct detail is not acceptable.
 - .7 Where applicable, a mockup of specific building envelope details and constructions will be required for review by the designer and building envelope consultant (ie. Windows, curtain wall, etc.). The purpose of the mockups is to confirm installation detailing, constructability and methodology.
 - .8 Routine and regular inspection of the constructed building envelope details and connections by the designer, general contractor and building envelope consultant are required.
- .6 Material & Compatibility
- .1 Materials used in the construction of the building envelope will not be moisture sensitive or will have adequate protection from moisture ingress or condensation.
 - .2 All materials used in the construction of the building envelope will be suited for the use and approved by the designer. The building envelope consultant may also provide technical input into material selection.
 - .3 Given the wide range of products and trades used in the construction of the building envelope, ensuring the compatibility of materials to be joined will be the responsibility of the designer, the contractor, and the sub-contractors equally.
- 1.4 Structural
- .1 Thermal Bridges in exterior wall cavities resulting from the placement of structural members are to be minimized if not eliminated.
 - .2 Design consideration must be given to the anticipated building movements and deflections, their location, and their effect on the building envelope components. Damage to the building envelope from anticipated movement shall not be acceptable.
 - .3 Properly detailed building envelope construction joints and connections will be required at locations of anticipated building movement.

1.5 Mechanical

- .1 Any mechanical work to be installed/modified within the exterior wall system is to be properly tied into the building envelope and not compromise the performance of the building envelope.
- .2 Any mechanical water piping to be installed/modified within the exterior wall system is to be free of leaks and protected from freezing.
- .3 All mechanical penetrations through the building envelope must be sealed against air leakage, water penetration and not be designed to promote condensation within the exterior wall system
- .4 All unforeseen penetrations through the building envelope must be reported to the contractor for review and a proper tie in to the building envelope must be provided.

1.6 Electrical

- .1 All electrical penetrations in the building envelope must be sealed against air leakage and water penetration.
- .2 All unforeseen penetrations through the building envelope must be reported to the contractor for review and a proper tie in to the building envelope must be provided.
- .3 Any electrical work to be installed within the exterior wall system is to be properly tied into the building envelope and not compromise the performance of the building envelope.

1.7 NECB Compliance Report

- .1 Complete NECB Compliance Report is attached as Appendix A. The NECB 2017 and National Building Code 2020 are being used for this project.

2. PRODUCTS

2.1 Not used

3. EXECUTION

3.1 Performance Mock-up (PMU) Testing

- .1 Introduction: size and details including in the PMU will be determined as the design and contract documents develop. Notify Consultant when mock-ups are ready for review. Consultant will arrange parties needed to attend fabrication, assembly at the lab and testing mock-ups.
- .2 Testing must be conducted by an independent lab having no affiliations with the Contractor, fabricators and/or erectors of the window wall assemblies, and which has continuous experience of the type of work specified, satisfactory to the Owner, Construction Manager, Consultant and Contractor.
- .3 Shop drawings must be submitted, drawn to scale, which show all components of the test assemblies, the test frame and enclosures, and the fastening of the test assemblies to the test frame. Test assemblies are to include viewing ports in the framing as directed by the Consultant.
- .4 Test assemblies must include all components, aluminum framing, glass and glazing, spandrels, gaskets, tapes, sealants, insulation, air/vapour barriers, flashing, anchors, connections and attachments as will be used on the building assembly. The test assemblies must be installed by the same personnel that will be working on the project.

3.2 Required Test Procedures

- .1 Air leakage test in accordance with ASTM E779 (Standard Test Method for Determining Air Leakage by Fan Pressurization). Test for air leakage, with air leakage rate not to exceed 0.6 air changes per hour at 50 Pa static pressure difference.
- .2 Static air infiltration test in accordance with ASTM E283 (Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors). Air infiltration shall not exceed the Specification requirements. Test for air infiltration and exfiltration at 75 Pa static pressure difference, with the leakage rate not to exceed 0.15 l/s/m².
- .3 Static Water Penetration Test in accordance with ASTM E331 (Test Method for Water Penetration of Exterior Curtain Wall, Window Wall and Doors by Uniform Static Air Pressure Difference). Water infiltration shall not exceed the Specification requirements, however the typical requirement is no infiltration of water inboard of the air barrier plane or retained within the window wall assembly. Test for water penetration under a static pressure difference of 720 Pa for a period of 15 minutes.
- .4 Dynamic Water Penetration Test in accordance with AAMA 501.1 (Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors using Dynamic Pressure). Water infiltration shall not exceed the Specification requirements, however the typical requirement is no infiltration of water inboard of the air barrier plane or retained within the window wall assembly. Test for water penetration under a dynamic pressure difference of 720 Pa for a period of 15 minutes.
- .5 Static Structural Performance Test in accordance with ASTM E330 (Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference). Test requirements to be determined based on design wind loads.
- .6 Inter-Storey Movement Test in accordance with AAMA 501.7 (Test Method for Evaluating Windows, Window Wall, Curtain Wall and Storefront Systems Subjected to Vertical Inter-Storey Movements). Each test to include a minimum of three movement cycles. Test movement requirements determined based on anticipated slab deflection criteria as determined by the structural engineer (typically not less than +/-19 mm displacement).
- .7 Condensation Resistance/Thermal Cycling Test (AAMA 501.5 and AAMA 1501.3) consisting of at least 5 cycles ranging from approximately -32°C to +60°C exterior and 21°C interior (as per the Specification requirements). Maintain one cycle at -32°C exterior temperature until such time that the test assembly stabilizes, and held for a period of 2 hours after equilibrium is achieved. At interior design conditions (21°C at 20% RH, confirm with mechanical engineer) condensation on room side surfaces shall not exceed allowable limits.

3.3 Test Procedure:

- .1 Preload to 50% positive Design Wind for 10 sec. (ASTM E330)
- .2 Air leakage not to exceed 0.6 air changes per hour at 50 Pa static pressure difference (ASTM E779).
- .3 Air Infiltration/Exfiltration at 75 Pa. (ASTM E283)
- .4 Static Water Infiltration at 720 Pa. (ASTM E331)
- .5 Dynamic Water Infiltration at 720 Pa. (AAMA 501.1)
- .6 Structural Performance at 75% & 100% Design Wind for 10 sec. (ASTM E330)
- .7 Repeat Air Infiltration/Exfiltration.
- .8 Repeat Static Water Infiltration.

- .9 Inter-Storey Movement, 3 cycles. (AAMA 501.7)
- .10 Repeat Static Air Infiltration/Exfiltration.
- .11 Repeat Static Water Infiltration.
- .12 Repeat Dynamic Water Infiltration.
- .13 Condensation Resistance/Thermal Cycling, 5 cycles, 1 cycle to be used as Condensation Resistance test. (AAMA 501.5 and AAMA 1501.3)
- .14 Repeat Static Air Infiltration/Exfiltration
- .15 Repeat Static Water Infiltration
- .16 Structural Performance at 1.5X Design Wind Load. (ASTM E 330)
- .17 Swingstage Tie-back Load Test. Apply a load of 2.67 kN, in all directions and hold for a 10 second period.

3.4

Additional Testing:

- .1 If the mockup assemblies fail to meet the performance criteria of the Specifications, all costs associated with modifications, corrections and re-testing of the mock-up are typically carried by the glazing contractor until the mock-up passes the required performance criteria. Costs include fees for witnesses to re-visit the test facility (i.e. accommodation, travel, subsistence, etc.).
- .2 Measuring bowing on aluminum spandrel panels (due to thermal movement).
- .3 Using clear glass in the spandrels to allow observation of moisture.
- .4 Wind load design is based on serviceability; test at 75% of design (in addition to 100% and 150%) and compare design to tests (included in the above).

END OF SECTION

Project No: 144214760

1. GENERAL

1.1 Summary

- .1 Provide common work results for fire rated separations and assemblies in accordance with requirements of Contract Documents.

1.2 Design Requirements

- .1 Conform to listed requirements to maintain the continuity of fire separations whether or not shown on the drawings.
- .2 Firestop openings and joints in fire rated construction with non-combustible material specified in Section 07 84 00 where a fire separation or assembly is required to be of non-combustible construction and terminates at the exterior wall, the underside of floor, ceiling, or roof structures, and at floors.
- .3 Do not support non-combustible construction on or from combustible construction.
- .4 Firestop openings for non-combustible pipes and ducts to prevent the passage of smoke and flame; Subcontractors shall be responsible for installing firestopping where their work passes through a fire separation, the opening shall be plugged with ULC labelled and approved firestopping sealant, insulation or other material approved by local Authorities Having Jurisdiction to maintain the integrity of the fire separations.
- .5 Existing fire separations must be maintained as such, and any cutting must be sealed to retain the separation's assembly rating.
- .6 Do not use combustible members, fastenings, and similar items to anchor fixtures to fire separations.
- .7 Refer to technical sections for specific requirements for sealing penetrations and joints of smoke and fire separations.
- .8 Do not pierce fire separations with electrical or similar service outlets except in accordance with the Building Code.

1.3 References

- .1 National Fire Protection Association (NFPA):
 - .1 NFPA 80, Standard for Fire Doors and Other Opening Protectives
 - .2 NFPA 252, Standard Methods of For Tests of Door Assemblies
- .2 Underwriters Laboratories Canada (ULC):
 - .1 CAN/ULC 101, Standard Methods of Fire Endurance Tests of Building Construction and Materials

1.4 Fire Test Response Characteristics

- .1 Fire resistance rated assemblies and materials will only be accepted from an organization recognized by the Authority Having Jurisdiction as being capable of conducting testing and providing labelling for materials, assemblies and systems that include, but are not limited to, the following organizations:
 - .1 Underwriters Laboratories of Canada (ULC).
 - .2 Underwriters Laboratories Inc. (UL).
 - .3 Intertek-Warnock Hersey (I/WH) ETL Semko.

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- .4 Acceptance of UL or WHI labels are subject to the following conditions:
 - .1 Fire resistance rated assemblies and materials bearing an Underwriter's Laboratories Inc. (UL) or Intertek-Warnock Hersey (I/WH) label will be acceptable for use on this project provided that the label indicates acceptance under Underwriters Laboratories of Canada (ULC) and having either a cUL, cUL_{US}, cI/WH or cI/WH_{US} marking.
 - .2 Materials that only have a UL, UL_{US}, I/WH or I/WH_{US} marking will not be acceptable.
- .5 Examples of acceptable marks from Recognized Testing Authorities:



- .2 Provide materials and construction identical to those tested in assembly indicated according to CAN/ULC S101 for assemblies or materials having fire resistance ratings, as verified by an independent testing and inspecting agency acceptable to Authorities Having Jurisdiction for fire resistance ratings of specific assemblies indicated on drawings:
- .3 Fire resistance rated assemblies and materials shall bear a label and proof of acceptance as indicated by design designations from ULC List of Equipment and Materials or Warnock Hersey-Intertek Directory of Listed Products. Where no design designation is provided, use only time assigned to materials listed in the Building Code.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide cold applied emulsified bituminous dampproofing in accordance with requirements of the Contract Document for foundation walls.

1.2 References

- .1 ASTM International (ASTM):
- .1 ASTM D1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing

1.3 Submittals

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:

- .1 Product Data: Submit product data sheets for bituminous dampproofing products including; but not limited to, the following:
- .1 Product characteristics.
- .2 Performance criteria.
- .3 Application methods.
- .4 Limitations.

- .2 Informational Submittals: Provide the following submittals when requested by the Consultant:

- .1 Manufacturer's Instructions: Submit manufacturer's written installation instructions indicating:
- .1 Special handling criteria.
- .2 Surface preparation.
- .3 Environmental restrictions.
- .4 Installation sequence.
- .5 Application and cleaning procedures.

1.4 Quality Assurance

- .1 Regulatory Requirements:

- .1 Safety: Install materials in accordance with provincial occupational health and safety legislation, and Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers and caulking materials.
- .2 Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces; maintain ventilation until dampproofing materials are cured.

- .2 Source Limitations:

- .1 Primary Materials: Obtain primary dampproofing materials and primers from one source and a single manufacturer.
- .2 Secondary Materials: Obtain secondary materials recommended by manufacturer of, and compatible with primary dampproofing materials.

1.5 Delivery, Storage and Handling

- .1 Deliver, handle, store and protect materials in accordance with manufacturer's instructions and as follows:

- .1 Store materials in dry, off ground weatherproof storage.
- .2 Use only in quantities required for same day use.

1.6 Site Conditions

- .1 Ambient Conditions: Install dampproofing materials only when existing and forecasted weather conditions permit dampproofing installation in accordance with manufacturer's written instructions, and as follows:
 - .1 Do not proceed with Work when wind chill effect would tend to set bitumen before proper curing takes place.
 - .2 Do not apply dampproofing in wet weather.

2. PRODUCTS

2.1 Materials

- .1 Emulsion Type Dampproofing Coating: Asphaltic, water based emulsion dampproofing, asbestos free, designed for application to exterior side of below grade foundations and walls, containing no solvents in accordance with ASTM D1227 and as follows:
 - .1 Application Temperature: 10°C and rising.
 - .2 Grade: Spray - Type III or II, Class 1
 - .3 VOC Content: Maximum 30 g/L (less water and exempt solvents)
 - .4 Acceptable Materials:
 - .1 Euclid Chemical Dehydratine 75
 - .2 Henry 700-01
 - .3 W. R. Meadows Sealmastic Type 1
 - .5 Solvent based for cold weather applications: Henry 810-07

2.2 Accessories

- .1 Protection Board: Asphalt impregnated fibreboard, 13 mm thickness.
- .2 Board Insulation: Plastic foam foundation insulation as specified in Section 07 23 00.
- .3 Asphalt Primer: Primer as recommended by dampproofing manufacturer.
- .4 Patching Compound: Fibered mastic compound as recommended by dampproofing manufacturer.
- .5 Reinforcing Fabric: Asphalt coated glass fabric as recommend by dampproofing manufacturer.

3. EXECUTION

3.1 Examination

- .1 Examine substrates and verify that surface smoothness, moisture emissions and other conditions affecting performance of materials specified in this Section complies with the dampproofing manufacturer's recommended substrate requirements.

3.2 Preparation

- .1 Protect and mask adjoining exposed surfaces from being stained, spotted or coated with dampproofing; prevent dampproofing materials from entering or clogging weep holes, drains and perimeter drainage systems.
- .2 Seal exterior joints between foundation walls and footings, joints between concrete floor slab and foundation and around penetrations through dampproofing with sealing compound and reinforcing fabric before applying dampproofing.
- .3 Clean substrates, remove projections; fill voids and apply bond breakers (if required), and apply primer as recommended by dampproofing manufacturer.

3.3 Application

- .1 General: Apply dampproofing to provide a continuous plane of protection to foundations and footings in accordance with manufacturer's written recommendations and as follows:
 - .1 Allow for additional coats to achieve required coverage.
 - .2 Allow sufficient drying time between successive coats.
 - .3 Allow sufficient drying time before backfilling.
- .2 Apply dampproofing to exterior side of foundations and footings starting from finished grade line to top of footing, extending across top of footing and down a minimum of 150 mm over outside face of footing, and as follows:
 - .1 Do not permit dampproofing to extend onto surfaces exposed to view in final construction.
 - .2 Reinforce changes in direction greater than 45° at intersections, projecting surfaces, internal and external corners, changes in plane, and across construction joints, cracks and honeycombing; apply additional coat of dampproofing material to embed reinforcing fabric into primary dampproofing membrane; extend reinforcing fabric 200 mm to each side of areas requiring reinforcing.
- .3 Install protection board over completed and cured dampproofing; attach as recommended by dampproofing manufacturer.
- .4 Install insulation board into dampproofing before membrane has skinned over in accordance with dampproofing manufacturer's written instructions.

3.4 Cleaning

- .1 Remove dampproofing materials from surfaces not intended to receive dampproofing.

END OF SECTION

1 GENERAL

1.1 Summary

- .1 Provide building insulation in accordance with requirements of Contract Documents.
- .2 Refer to Section 07 52 16 for roof assembly.
- .3 Refer to Section 09 21 16 for insulation batts with interior partitions.

1.2 References

- .1 ASTM International (ASTM):
 - .1 ASTM C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - .2 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .3 ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
 - .4 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .5 ASTM C1015, Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation.
 - .6 ASTM C1303/C1303M, Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation.
 - .7 ASTM D1621, Standard Test Method for Compressive Properties of Rigid Cellular Plastics
 - .8 ASTM D1622/C1622M, Standard Specification for Cold-Weather Admixture Systems.
 - .9 ASTM D2842, Standard Test Methods for Water Absorption of Rigid Cellular Plastics
 - .10 ASTM D5113, Standard Test Method for Determining Adhesive Attack on Rigid Cellular Polystyrene Foam
 - .11 ASTM D6226, Standard Test Method for Open Cell Content of Rigid Cellular Plastics.
 - .12 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .13 ASTM E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
- .2 Canadian General Standards Board (CGSB):
 - .1 CGSB 71-GP-24M, Adhesive, Flexible, for Bonding Cellular Polystyrene (withdrawn)
- .3 Underwriters Laboratories Canada (ULC):
 - .1 CAN/ULC S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - .2 CAN/ULC S114, Test for Determination of Non-Combustibility in Building Materials
 - .3 CAN/ULC S129, Standard Method of Test for Smoulder Resistance of Insulation (Basket Method)
 - .4 CAN/ULC S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering
 - .5 CAN/ULC S702,
 - .6 CAN/ULC S704, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced
 - .7 CAN/ULC S770, Standard Test Method for Determination of Long-term Thermal Resistance of Closed-Cell Thermal Insulating Foams

1.3 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
 - .1 Manufacturer's literature, specifications and installation instructions describing general properties of each material and accessory used in the Work.

1.4 Delivery, Storage and Handling

- .1 Storage and Handling Requirements: Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

2. PRODUCTS

2.1 Materials

- .1 Foundation Wall Insulation: Polystyrene, extruded type, in accordance with CAN/ULC S701, Type 4, thermal resistance not less than RSI 0.87/25 mm; square edges, board size 610 mm x 2440 mm x [thickness required to achieve insulation value indicated on Drawings; minimum compressive strength 170 kPa at 10% deformation in accordance with ASTM D1621, water absorption (% by volume) maximum 0.7% in conformation with ASTM D2842:
 - .1 Acceptable Materials:
 - .1 Dow Styrofoam SM or Dow RoofMate
 - .2 Owens-Corning Celfort 300
 - .3 Soprema Sopra-XPS 30
 - .2 Load Bearing Insulation (under slabs): XPS Polystyrene, high density extruded type in accordance with CAN/ULC S701, Type 4, thermal resistance not less than RSI 0.87/25 mm; square edges, board size 610 mm x 2440 mm x thickness as indicated on Drawings; minimum compressive strength 275 kPa at 5% deformation in accordance with ASTM D1621, water absorption (% by volume) maximum 0.7% in conformation with ASTM D2842:
 - .1 Acceptable Materials:
 - .1 Dow Styrofoam, Hiload 40
 - .2 Owens-Corning, Foamular 400
 - .3 Soprema Sopra XPS 40
 - .3 Load Bearing Insulation (under thickened slabs and footings): XPS Polystyrene, high density extruded type in accordance with CAN/ULC S701.1, Type 4, thermal resistance not less than RSI 0.87/25 mm; square edges, board size 610 mm x 2440 mm x thickness as indicated on Drawings; minimum compressive strength 415 kPa at 5% deformation in accordance with ASTM D1621, water absorption (% by volume) maximum 0.7% in conformation with ASTM D2842:
 - .1 Acceptable Materials:
 - .1 Dow Styrofoam, Hiload 60
 - .2 Owens-Corning, Foamular 600
 - .3 Soprema Sopra XPS 60
 - .4 Perimeter Insulation: Premanufactured concrete faced polystyrene, extruded type, in accordance with CAN/ULC S701.1, Type 4, thermal resistance not less than RSI 0.87/25 mm; tongue and groove edges, board size 610 mm x 1220 mm x thickness required to achieve insulation value indicated on Drawings with 8 mm concrete topping; minimum compressive strength 240 kPa at 10% deformation in accordance with ASTM D1621, water absorption (% by volume) maximum 0.7% in conformation with ASTM D2842:
 - .1 Acceptable Materials:
 - .1 Tech-Crete, CFI Wall Panels
 - .2 WallGuard Wall Panels

- .5 Fibrous Mineral Wall Insulation: Unfaced, preformed rigid fibrous mineral slag board insulation in accordance with CAN/ULC S702, Type 1, thermal resistance not less than RSI 0.74/25 mm; rated non-combustible in accordance with CAN/ULC S114 and having a flame spread rating of 5 or less in accordance with CAN/ULC S102; density 72 kg/m³; square edges, board size 406 mm x 1220 mm x thickness indicated on Drawings:
- .1 Acceptable Materials:
- .1 Fibrex CWB 45
 - .2 Thermafibre Rain Barrier
 - .3 Rockwool CavityRock
- .6 Glass Fibre Insulation: Unfaced, preformed glass fibre batt insulation in accordance with CAN/ULC S702, Type 1; having a nominal RSI of 0.55/25 mm, thickness as required to meet design insulation values indicated on drawings or as required to fill insulated spaces where not indicated; GreenGuard™ certified or formaldehyde free, manufactured using recycled glass, and as follows:
- .1 Acceptable Materials:
- .1 CertainTeed Sustainable Insulation
 - .2 Johns-Manville Formaldehyde Free Batt Insulation
 - .3 Knauf EcoBatt Insulation
 - .4 Owens-Corning Canada Inc., Pink Fiber Glass Insulation
 - .5 Rockwool Plus
- .7 Mineral Fibre Insulation: Unfaced, preformed mineral slag batt insulation in accordance with CAN/ULC S702, Type 1; having a nominal RSI of 0.67/25 mm; rated non-combustible in accordance with CAN/ULC S114 and having a flame spread rating of 5 or less in accordance with CAN/ULC S102; density 32 kg/m³; square edges, thickness as required to meet design insulation values indicated on drawings or as required to fill insulated spaces where not indicated, and as follows:
- .1 Acceptable Materials:
- .1 Fibrex, SAFB Insulation
 - .2 Rockwool Plus
- 2.2 Materials in Other Sections
- .1 Roof Insulation: Refer to roofing section, insulation types specific to roofing are specified as a part of roof system requirements.
- .2 Refer to Section 07 52 16 for roof assembly.
- .3 Refer to Section 09 21 16 for insulation batts with interior partitions.
- 2.3 Accessories
- .1 Insulation Fasteners:
- .1 Mechanical Fasteners: High quality, impact resistant plastic fastener system specifically designed for installation of board insulation materials; 38 mm diameter, shaft length to suit insulation thickness and hot dipped galvanized fastener to suit substrate, and as follows:
- .1 Basis-of-Design Materials: Ucan Fastening Systems, Insulation Fasteners; alternates will be considered for this material.
- .2 Insulation Adhesive:
- .1 Trowelable Polystyrene Insulation Adhesive: Trowel consistency, synthetic rubber based insulation adhesive compatible with polystyrene insulation in accordance with CGSB 71-GP-24M; suitable for application to temperature of -10°C or lower:
- .1 Basis-of-Design Materials: Henry, 230-21 Rigid Insulation Adhesive; alternates will be considered for this material.

- .3 Perimeter Insulation Flashings: Coordinate supply of end closures and flashings for perimeter insulation system with Section 07 62 00.
- .4 Adhesive for Bonding Insulation: Provide type recommended by the insulation manufacturer to suit conditions of each application.
- .5 Supports and Anchors for Insulation: Provide type shown and as recommended by insulation manufacturer. Provide galvanized steel skewers or mechanically attached clips as recommended by the insulation manufacturer when insulation is applied to metal construction.
- .6 Adhesive–Applied Clips: Not allowed.
- .7 Protection Board: Pre-moulded, semi-rigid asphalt/fibre composition board, minimum 6 mm thick, formed under heat and pressure as recommended by board insulation manufacturer for below grade installations.

3. EXECUTION

3.1 Site Conditions

- .1 Weather Conditions: Do not proceed with the exterior exposed Work during inclement weather nor when weather forecasts are unfavorable, unless the Work will proceed in accordance with the manufacturer's requirements and instructions and any agreements or restrictions of the Pre–Construction Conference.

3.2 Examination

- .1 Examine substrates and conditions for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.
- .2 Verify that surfaces which are to receive rigid insulation are clean, free of deleterious matter and are sufficiently level to allow the proper installation of insulation.
- .3 Verify that flashings provided under other Sections are installed and that they divert moisture to exterior of insulated systems.

3.3 Preparation

- .1 Clean substrates of substances harmful to insulations; remove projections that interfere with insulation attachment.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 Installation

- .1 General: Install the insulation materials in accordance with the manufacturers' instructions, except where more stringent requirements are shown or specified. Extend insulation full thickness over entire area to be covered unless otherwise shown. Cut and fit or form insulation tightly around obstructions and penetrations so that no voids exist in the insulation course.
- .2 Insulation in Fire–Rated Systems: Refer to Section 07 84 00 for materials to be used in fire rated construction for through–penetrations, firestop joints, and perimeter fire containment systems.
- .3 Mechanical Attachment: Provide type and spacing of mechanical anchoring devices as shown and as recommended by the insulation manufacturer for the thickness and condition of use shown.
- .4 Application of Perimeter Foundation Insulation: Coordinate with foundation waterproofing system. Apply a single layer of extruded polystyrene board insulation in thickness as indicated. Bond insulation to substrate with adhesive as recommended by insulation manufacturer, and press into place so that entire board is bonded. Support insulation temporarily until adhesive bond is sufficient to hold weight of insulation.

- 3.5 Protection
- .1 Protect installed board insulation from damage due to harmful weather exposures, physical abuse, and other causes.
 - .2 Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

1. GENERAL

1.1 Summary

.1 Provide air and vapour membrane in accordance with requirements of the Contract Document.

.2 Section Includes:

- .1 Air/vapour barrier membrane.
- .2 Sheet metal support for membrane.
- .3 Materials and installation methods supplementing other primary air seal materials and assemblies.
- .4 Air seal materials to bridge and seal openings and penetrations of aluminum window frames, entrance frames, hollow metal door frames, louvres, mechanical and electrical protrusions and all other protrusions through the plain of the air seal / vapour retarder.

1.2 References

.1 ASTM International (ASTM):

- .1 ASTM C1193: Standard Guide for Use of Joint Sealants
- .2 ASTM D882: Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
- .3 ASTM D903: Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
- .4 ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
- .5 ASTM E96/E96M: Standard Test Methods for Water Vapor Transmission of Materials
- .6 ASTM E154/E154M: Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
- .7 ASTM E283: Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
- .8 ASTM E330/E330M: Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- .9 ASTM E783: Standard Test Method for Field Measurements of Air Leakage Through Installed Exterior Windows and Doors.
- .10 ASTM E1186: Standard Practices for Air Leakage Site Detection in Building Envelope and Air Barrier Systems.
- .11 ASTM E1643: Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
- .12 ASTM E1745: Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- .13 ASTM E2178: Standard Test Method for Air Permeance of Building Materials.
- .14 ASTM E2357: Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.

.2 Canadian General Standards Board (CGSB):

- .1 CAN/CGSB 51.34: Vapour Barrier, Polyethylene Sheet for Use in Building Construction
- .2 CGSB 149-GP-2: Manual for Thermographic Analysis of Building Enclosures

.3 Underwriters Laboratories Canada (ULC):

- .1 ULC 741: Standard for Air Barrier Materials - Specification
- .2 ULC 101: Standard Methods of Fire Endurance Tests of Building Construction and Materials.
- .3 ULC 102: Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .4 ULC 114: Standard Method of Test for Determination of Non-Combustibility in Building Materials.
- .5 ULC 134: Standard Method of Fire Test of Exterior Wall Assemblies.

1.3 Definitions

- .1 The air/vapour barrier for the purpose of these specifications, is a membrane which performs two functions, air barrier and vapour retarder as defined below.
- .2 The definition of the vapour retarder for the purpose of these specifications is a continuous membrane including joints of membrane to adjacent construction and to itself which retards the passage of moisture as it diffuses through the assembly of materials in the wall.
- .3 The definition of the air barrier for the purpose of these specifications is a continuous membrane that is solidly supported by a back-up material (ie. Exterior sheathing), including joints of membrane to adjacent construction and to itself, which stops outside air from entering the building through the walls, windows and inside air from exfiltration through the building envelope to the outside.

1.4 Performance Requirements

- .1 Be responsible for establishing that sealing work as indicated and specified is carried out correctly and in accordance with the overall intent of this Section.
- .2 The air/vapour barrier must be continuous through the building envelope. The air/vapour, barrier membrane of the wall must be continuous with the existing air/vapour barrier.
- .3 The air/vapour barrier must be fastened to the supporting structure to resist a peak wind load, and sustained stack effect or pressurization from ventilation equipment; it must be sufficiently rigid to resist displacement.
 - .1 The materials and configuration of the air/vapour barrier assembly must resist the highest expected air pressure load, inward or outward, without rupturing or detaching for the support.
 - .2 The assembly must not creep away from the substrate or part at a joint under sustained pressure difference.
 - .3 The deflection of the air/vapour barrier materials between supports must be minimized to prevent the displacement of other materials.
 - .4 The air/vapour barrier system (mean area plus joints) must be virtually air impermeable.
 - .5 A combined air/vapour barrier system must meet the requirements of the air barrier and vapour retarder functions.
 - .6 Use galvanized sheet steel as a substrate to support the air/vapour barrier membranes as necessary.
 - .7 The air/vapour barrier installation must be designed and installed to accommodate building movement without rupture.
- .4 Building sealing comprises of the following:
 - .1 Prevention of entry of air and water into interior building spaces.
 - .2 Prevention of air leakage from inside of the building.
 - .3 Control of water vapour migration.
- .5 Prevent interior air leakage through gaps in air/vapour barrier membrane which cause condensation or frost accumulation.
- .6 Where air/vapour barriers are specified or indicated, ensure that no gaps, openings, or cracks are left. Seal all cracks, gaps, etc. to satisfaction of the Consultant.
- .7 The method for prevention of air leakage is indicated or specified. Ensure that the work is carried out fully and correctly.

- .8 The air/vapour barrier must be installed by a manufacturer's approved installer having a minimum of 2 years documented experience in the installation of the product on similar projects. The manufacturer must submit a written declaration that the air/vapour barrier installation including connection to other vapour retarders, air barrier and membranes is done in accordance with the manufacturer's specifications and recommendations to achieve a complete air/vapour barrier.
- .9 Use only one type of torched on air/vapour barrier and one type of self adhered air/vapour barrier throughout the project. Notwithstanding any trade scope definitions, install all air/vapour barrier using only one installer for all work of this project, except at connections of air/vapour barrier to window framing.

1.5 Administrative Requirements

- .1 Pre-Construction Meeting: Arrange a pre-construction meeting 1 week before commencing work of this Section to discuss installation requirements of specified air and vapour membrane systems, manufacturer's site review, and location for site constructed mock-up listed in this Section attended by Contractor, Subcontractor for work of this Section, manufacturer's technical representative and others affected by work of this Section. Manufacturer's technical representative to submit written report summarizing their attendance at the meeting, review of appropriate products and discussion with installing trade.
- .2 Coordination: Coordinate interface of membranes specified in this Section with adjacent systems to ensure continuity of system and that junctions between various components are effectively sealed; verify with manufacturers and installers for installation procedures of materials incorporated into air and vapour membrane elements including membranes, transitions, coatings and sealants and continuity with roofing membrane.

1.6 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
 - .1 Submit manufacturer's product literature, and installation instructions required for complete and proper installation of air and vapour retarder elements including membranes, primers, fasteners, proprietary application equipment, etc.
- .2 Samples: Submit for Consultant's action. Submit two (2) samples prior to starting work of this section as follows; accepted samples will form the standard of acceptance for the remainder of the work:
 - .1 Submit representative sample of air and vapour membrane minimum 300 mm x 300 mm with factory applied identification clearly visible.
- .3 Quality Control Submittals: Submit for Consultant's action. Provide proof of qualifications:
 - .1 Manufacturer: Obtain air and vapour membrane materials through one source from a single manufacturer or using materials from a secondary source that are acceptable to the manufacturer.
 - .2 Installer: Use an installation company that is acceptable to the manufacturer, using workers who are trained and approved by the membrane manufacturer having experience

1.7 Pre-installation Conference

- .1 Before commencement of air/vapour barrier work, arrange a pre-installation conference to be attended by the Construction Manager, Subcontractor's Superintendent, representatives of the suppliers of the air/vapour barrier membrane, the adjoining membranes which lap with the air/vapour barrier membrane, and the aluminum windows. Arrange this meeting only when the representative of the Consultant can attend. Methods of operation, and trade responsibility will be resolved.

1.8 Reviews

- .1 Do not cover any portion of the air/vapour barrier installation, including foam-in-place insulation, until it has been reviewed and accepted by the Consultant. Reviews of the air/vapour barrier membrane installation, before application of covering materials, is MANDATORY. There will be no exceptions.
- .2 If considered necessary by the Consultant, Thermal scanning of the building may be performed after the building is enclosed and heated, to detect air leakage and heat loss. Cost of initial thermographic scan will be borne by the Owner. Repair all defective areas discovered with the thermographic scan at no cost to the Owner. Contractor is to provide all reasonable assistance as required to the Scanning Agency.
- .3 Remove cladding to access the defect area using same trade who initially installed cladding. Repair defect or gap in air/vapour barrier and reinstall cladding using original installer.
- .4 When the repairs have been completed, another thermographic scan will be done to ensure that the repairs have been properly performed and to ensure that all defects have been repaired. The cost of this thermographic scans will be borne by the Subcontractor.
- .5 If further defects are detected, perform additional repairs, and perform an additional thermographic scan to verify that the air barrier is continuous and complete. Pay all costs of such additional repairs and thermographic scans.

1.9 Environmental Requirements

- .1 Do not install solvent curing or vapour release materials in enclosed spaces without ventilation.
- .2 Maintain temperature and humidity recommended by the materials manufacturers before, during and after installation.
- .3 Apply air/vapour barrier only when substrate is dry and free of moisture or frost.

1.10 Coordination

- .1 Coordinate the installation of sheet air/vapour barrier with other parts of the work to achieve an air tight building envelope.
- .2 Ensure that air/vapour barrier materials used at junctions between different parts of the Work are compatible with each other and with other adjacent materials such as foam-in-place insulation around window framing and protrusions. Ensure self adhere membrane is
- .3 compatible with substrate and below grade dampproofing. Ensure self adhere membrane is compatible with torched on membrane.

1.11 Sequencing

- .1 Sequence work to permit installation of materials in conjunction with related materials and seals.
- .2 Sequencing to be developed to allow for positive overlap, or shingling style of installation, avoiding negative laps.

1.12 Product Delivery, Storage, and Handling

- .1 Deliver sheet air/vapour barrier materials in factory-wrapped rolls with labels indicating manufacturer and trade name and material type, thickness, roll width and area.
- .2 Protect materials from direct exposure to sunlight and physical damage.

- .3 Protect materials from weather by use of raised platforms and waterproof covering. Do not double stack pallets on the job site.
- .4 Protect materials from temperatures in excess of 32 degrees C.
- .5 Store mastic and liquid materials in dry area, away from high heat, open flames and sparks.

2. PRODUCTS

2.1 Performance Requirements

- .1 Provide materials and installations that meet the following material and assembly performance ratings and as follows:
 - .1 Material Performance: Provide materials having an air permeance rating not exceeding 0.02 l/sec-m² measured at 75 Pa pressure differential in accordance with ASTM E2178; and having a vapour permeance rating not exceeding 3.5 g/sec-m² in accordance with ASTM E96/E96M.
 - .2 Assembly Performance: Install materials and accessories to provide a continuous air and vapour membrane assembly having an air leakage rate not exceeding 0.20 l/sec-m² measured at 75 Pa pressure differential in accordance with ASTM E2357; that will perform as the primary drainage plane flashed to direct condensation or water penetration to the exterior; that will accommodate movement of building materials and building expansion and contraction; and that has appropriate accessory materials to account for changes in substrate, transitions and other perimeter conditions.
 - .3 Refer to specification section 07 02 00 for requirements for air testing of the envelope and establish parameters that are to be met in the air test for the building envelope.
 - .4 Third party testing envelope testing and commission will be required for air tightness.

2.2 Materials

- .1 Air/Vapour barrier membrane (self-adhering type) including for all tie ins to windows, hollow metal door frames, louvres and the like. One of the following approved equals and associated accessories:
 - .1 Perm-A-Barrier as manufactured by GCP Applied Technologies.
 - .2 Tremco ExoAir 110
 - .3 CCW-705 as manufactured by Carlisle
 - .4 Blue Skin "SA" as manufactured by Henry.
 - .5 IKO Aquabarrier AVB
 - .6 Soprema Sopraseal Stick 1100.
 - .7 Air-Shield by WR Meadows
 - .8 3M self adhered
 - .9 Note that only one type is to be used throughout the project.
- .2 Air/Vapour barrier membrane (High Temp): provide air/vapour membrane rated for high temperatures at all parapet locations.
- .3 Air/Vapour barrier membrane (Low Temperature self-adhering type) including for all tie ins to windows, hollow metal door frames, louvres and the like. One of the following approved equals and associated accessories:
 - .1 Perm-A-Barrier LT as manufactured by GCP Applied Technologies.
 - .2 Tremco ExoAir 110 LT
 - .3 CCW-705LT as manufactured by Carlisle
 - .4 Blue Skin "SA LT" as manufactured by Henry Inc.
 - .5 IKO Aquabarrier AVB LT
 - .6 Soprema Sopraseal Stick 1100 TWG.
 - .7 Air-Shield XLT by WR Meadows
 - .8 Note that only one type is to be used throughout the project.

- .4 Thru-wall Flashing membrane (self-adhering type). One of the following approved equals and associated accessories:
 - .1 Perm-A-Barrier WF as manufactured by GCP Applied Technologies.
 - .2 Tremco ExoAir TWF
 - .3 CCW-705-TWF as manufactured by Carlisle
 - .4 Blue Skin TWF as manufactured by Bakor Inc.
 - .5 IKO Aquabarrier TWF
 - .6 Soprema Sopraseal WFM
 - .7 Air-Shield TWF by WR Meadows
 - .8 Note that only one type is to be used throughout the project.
- .5 Air/Vapour barrier membrane (Liquid applied): elastomeric bitumen, synthetic rubber, or polymer-modified; either sprayed or rolled on. One of the following approved equals and associated accessories:
 - .1 Air-Shield LM; manufactured by W.R. Meadows.
 - .2 Air-Bloc 06; manufactured by BAKOR.
 - .3 Barriseal; manufactured by Carlisle.
 - .4 Perm-A-Barrier Liquid as manufactured by GCP Applied Technologies.
 - .5 Sopraseal Retrofit; manufactured by Soprema.
 - .6 Note that only one type is to be used throughout the project.
- .6 Vapour Permeable membrane (self-adhering type). Refer to Section 07 27 27.

2.3 Miscellaneous Materials

- .1 Rubber asphalt sealant: Conforming to CAN/CGSB-37.29.
- .2 Primers, Adhesives and Undercoats: Manufacturer's recommended primer, adhesive or surface conditioner to improve bond between membranes to substrates having VOC content meeting or less than required for project sustainability requirements.
- .3 Sealants: as recommended by the membrane manufacturer.
- .4 Sheet metal membrane support: Z275 designation galvanized sheet metal commercial quality conforming to ASTM A653/A653M, minimum 0.91 mm (20 gauge) thickness.
- .5 Battens: channels formed of 1.2 mm base metal thickness, Z275 designation galvanized sheet steel, commercial quality conforming to ASTM A653/A653M, 19 mm wide with 9.5 mm legs.
- .6 Mechanical Fasteners: galvanized flat head screws, of type and size suitable for securing metal battens to substrate through air/vapour barrier and gypsum sheathing and into exterior wind bearing steel studs or into concrete or concrete block backup minimum 38 mm..

2.4 Fabrication of Sheet Metal Support

- .1 Brake form sheet metal to permit installation using self tapping, self-drilling screws or drilled anchors.
- .2 Make provisions in air/vapour barrier design to accommodate movement resulting from thermal change and from structural deflection.
- .3 Form 13 mm hem on sheet metal edges overlapped air/vapour barrier membrane, membrane flashing and waterproof membrane.
- .4 Cut, fit trim and form metal air/vapour barrier supports as required to accommodate conflicting framing connections.

3. EXECUTION

3.1 Examination

- .1 Verify that surface and conditions are ready to accept the Work of this Section. Notify the Consultant of unacceptable conditions. Do not start work until unacceptable conditions have been rectified.

3.2 Preparation

- .1 Remove loose or foreign matter which might impair adhesion of materials.
- .2 Clean and prime substrate surfaces to receive materials in accordance with manufacturer's instructions.

3.3 Installation/Membrane

- .1 Install materials in accordance with manufacturer's instructions.
- .2 Prime the wall and other surfaces using primer recommended by membrane manufacturer. Prime all surfaces receiving self-adhered membrane or strips, including gypsum board.
- .3 Before installing membrane to substrate in final position, allow the membrane to relax. Position membrane without stretching but tight enough to remove wrinkles.
- .4 Apply heavy pressure to membrane at top and bottom terminations of each sheet, using the back of a utility knife, to assure positive adhesion at the edge. Apply pressure over entire area, using small roller.
- .5 All side laps to be minimum 65 mm and all end laps to be 150 mm minimum as recommended by the manufacturer.
- .6 Carefully plan the installation in advance to avoid excessive layering of the membrane at laps and change in direction bends that will compromise the proper installation of later materials and components.
- .7 Completely adhere the entire membrane to the substrate after application of primer, and roll with a weighted roller, while membrane is still hot, in accordance with the manufacturer's instructions. Install membrane to achieve smooth wrinkle free surfaces, completely bonded to the substrate, without air entrapment.
- .8 Ensure complete coverage of (and adhesion to) all substrates to receive air/vapour barrier membrane, including all wall protrusions. Ensure co-operation of other trades to obtain continuity of the membrane.
- .9 Apply membrane so the horizontal joints overlap with the upper sheet over the lower sheet, shingle style.
- .10 Inspect membrane thoroughly before covering and immediately make any corrections or modifications required. Misaligned or inadequately lapped seams, punctures, fish mouths or other damage must be repaired with patch of membrane extending minimum 150 mm in all directions from edge of damaged area. Seal all edges of the patch with mastic. Slit fish mouths prior to repair with a membrane patch.
- .11 Fasten membrane to the substrate with vertical battens spaced 600 mm maximum centres, where not otherwise mechanically held in place. Place additional battens adjacent to openings, edges, and corners.

- .12 Fasten battens through the membrane to the studs at 300 mm centres, with the legs facing out. Bend up ends of battens and file smooth so that thermal movement will not cause end of batten to dig into membrane. Use battens in lengths not exceeding 1200 mm, and leave 25 mm gaps between ends of battens on the same alignment. Ensure laps occur over studs or firm bearing.
 - .13 Dress the membrane around corners. At all inside and outside corners, use 300 mm wide reinforcing piece of membrane strip, centred on corner, prior to installation of membrane as recommended by the membrane manufacturer. Cut, lap, and weld double return corners and other complicated changes of direction.
 - .14 At locations where membrane flashing is installed, ensure air/vapour barrier membrane is continuous behind membrane flashing. Sequence membrane flashing installation with air/vapour barrier installation, so that air/vapour barrier membrane overlaps top edge of membrane flashing, minimum 50 mm and is completely and continuously sealed in place to maintain air/vapour barrier and to shed water in cavity to the exterior through the weeping vents.
- 3.4 Field Quality Control
- .1 Make notification when sections of work are complete to allow review prior to covering fully self-adhered water-resistive vapor permeable air barrier system.
 - .2 Owner to engage independent consultant to observe substrate and membrane installation prior to placement of cladding system(s) and provide written documentation of observations.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide underslab sheet vapour retarder in accordance with requirements of Contract Documents.

1.2 References

.1 ASTM International (ASTM):

- .1 ASTM D1709 - Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
- .2 ASTM E96 - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
- .3 ASTM E154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
- .4 ASTM E1643 - Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- .5 ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
- .6 ASTM F1249 - Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

.2 American Concrete Institute (ACI):

- .1 ACI 302.2 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
- .2 ACI 302.1 Guide to Concrete Floor and Slab Construction.

1.3 Performance Requirements

- .1 Vapour Permeability (Perm): Maximum water vapour permeance of 0.01 perms (grains/(ft² · hr · inHg)) or less, measured to ASTM E1745 Class A.

1.4 Administrative Requirements

- .1 Coordination: Coordinate with other work having a direct bearing on work of this Section.
- .2 Pre-installation Meetings: Convene one (1) week before starting work of this Section.
- .3 Pre-installation conference shall include:
 - .1 Manufacturer's Inspection: representative to provide the following to assure quality and competence of membrane installation:
 - .1 Pre-installation training and supervision as required for personnel to install membrane.
 - .2 On-going, frequent inspection visits during installation.
 - .2 Adjacent System Interface:
 - .1 Coordination between all installers of each component of vapour retarder and air barrier system is essential to ensure continuity of system and that junctions between the various components are effectively sealed.
 - .2 Verify with Consultant installation procedures of building components incorporated into air barrier elements including, but not limited to: various membranes, coatings, sealants, as well as continuity of roofing membrane.

- .4 Sequencing:
 - .1 Sequence Work to permit installation of materials in conjunction with other retardant materials and seals and air barrier assemblies.
 - .2 Do not install vapour retarder until items penetrating it are in place.
 - .3 If climatic conditions may result in condensation between membranes and substrates, schedule installation of insulation to immediately follow installation of membranes.
 - .4 Sequence Work to permit installation of materials in conjunction with other related materials and seals, and air barrier assemblies.
 - .5 Install membranes over joints and gaps before installing membranes over adjacent substrates.

- 1.5 Submittals
 - .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
 - .1 Submit manufacturer's printed installation instructions including special handling criteria, installation sequence, cleaning procedures, and joint treatment and repair recommendations.
 - .2 Submit product data sheets for sheet vapour retarders indicating the following:
 - .1 Product characteristics.
 - .2 Performance criteria.
 - .3 Limitations.
 - .2 Provide duplicate 200 x 200 mm samples of membrane adhered to all Project substrates, including adjoining membranes specified in other Sections.
 - .3 Submit for Information when requested:
 - .1 Installation Data: Manufacturer's special installation requirements, including preparation and installation requirements, techniques.

- 1.6 Quality Assurance
 - .1 Perform Work in accordance with membrane manufacturer's requirements for materials and installation.
 - .2 Applicators' Qualifications:
 - .1 Trained and experienced in skills required for installation.
 - .2 Familiar with manufacturer's recommended methods of installation.
 - .3 Completely familiar with the requirements of this Specification Section.
 - .4 Periodic reviews by Consultant of all insulation materials installations, prior to covering up membrane is mandatory, with no exceptions.
 - .5 Only one manufacturer's membrane to be provided for this Project.

- 1.7 Delivery, Storage and Handling
 - .1 Deliver materials to Project site in original unopened packages, clearly marked with manufacturer's name, brand name, and description of content.
 - .2 Use all means necessary to protect membrane materials before, during and after installation and, to protect the installed Work of all other Subcontractors.
 - .3 Protect all materials by raised platforms and waterproof coatings.

- .4 Store membrane following manufacturer's instructions. Do not store in temperature above 32 degrees C for prolonged periods of time.
- .5 Store in dry area, away from heat, open flame, or sparks.

2. PRODUCTS

2.1 Under Slab Vapour Retarder

- .1 Sheet Vapour Retarder: manufactured from virgin polyolefin resins, sheet in accordance with ASTM E1745 Class A, for horizontal use below grade, under concrete slabs, including manufacturer's recommended seam tape, pipe boots and vapour proofing mastic forming a complete system, and as follows:
 - .1 Vapour Permeance: 0.01 Perm or less
 - .2 Water Vapour Transmission Rate: 0.57 ng/(s·m²·Pa)
 - .3 Tensile Strength: ASTM D882: 45 [52] lb/inch
 - .4 Puncture Resistance: ASTM D1709: 2200 [>3500] grams puncture resistance.
 - .5 Thickness: Not less than 15 mil in accordance with ACI 302R recommendations.
 - .6 Acceptable Materials:
 - .1 Stego Industries Stego Wrap Vapour Barrier 15 mil
 - .2 W.R. Meadows, Perminator 15 mil

2.2 Accessories

- .1 Thinner and Cleaner for Vapour Retarder Sheet: As recommended by sheet material manufacturer.
- .2 Perimeter and edge seal Attachments: Galvanized steel bars and anchors; or as detailed by manufacturer.
- .3 Joint Sealing Tape: Air resistant pressure sensitive adhesive tape, type recommended by vapour retarder manufacturer, minimum 100 mm width.
- .4 Pipe Collars: Construct pipe collars from vapour retarder material and pressure sensitive tape as recommended by manufacturer.
- .5 Fixed-elevation, point-to-point guide screed system that allows concrete installer to maintain floor levelness during the screeding operation. vapor barrier-safe, and helps easily satisfy the industry standard, ASTM E1643. Basis-of-Design: Stego Beast Screed System: foot; screed post and cap.

3. EXECUTION

3.1 Examination

- .1 Verify existing conditions before starting work.
- .2 Verify condition of substrate and adjacent materials.
- .3 Prepare substrate surfaces in accordance with vapour retarder manufacturer's printed instructions.

3.2 Preparation

- .1 Remove loose or foreign matter which might impair adhesion.
- .2 Clean and prime substrate surfaces to receive primer, sealants and adhesive in accordance with manufacturers' written instructions.

3.3 Installation

- .1 Install membranes in accordance with membrane manufacturers' recommendations, and to ensure continuity of air and vapour seal. Neatly trim membrane terminations.
- .2 Apply materials within recommended application temperature ranges. Consult manufacturer when materials cannot be applied within these temperature ranges.
- .3 Install Sheet Retarder to ASTM E1643 and manufacturer's instructions. Seal penetrations, including pipes.
 - .1 Unroll vapor barrier with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
 - .2 Extend vapor barrier to the perimeter of the slab. If practicable, terminate it at the top of the slab, otherwise (a) at a point acceptable to the structural engineer or (b) where obstructed by impediments, such as dowels, waterstops, or any other site condition requiring early termination of the vapor barrier. At the point of termination, seal vapor barrier to the foundation wall, grade beam or slab itself.
 - .1 Seal vapor barrier to the entire slab perimeter using manufacturer's instructions.
 - .2 Seal vapor barrier to the entire perimeter wall or footing/grade beam with double sided Tape, or both Termination bars and double sided Tape, in accordance with manufacturer's instructions. Ensure the concrete is clean and dry prior to adhering tape.
 - .3 Overlap joints 300 mm and seal with manufacturer's seam tape.
 - .4 Apply seam tape to a clean and dry vapor barrier.
 - .5 Seal penetrations (including pipes) in accordance with manufacturer's instructions.
 - .6 For interior forming applications, avoid the use of non-permanent stakes driven through vapor barrier. Use manufacturer recommended boots as a vapor barrier-safe forming system. Ensure peel-and-stick adhesive base is fully adhered to the vapor barrier.
 - .7 If non-permanent stakes must be driven through vapor retarder, repair as recommended by vapor retarder manufacturer.
 - .8 Use reinforcing bar supports with base sections that eliminate or minimize the potential for puncture of the vapor barrier. Stego Beast Screed.
 - .9 Repair damaged areas with vapor barrier material of similar (or better) permeance, puncture and tensile; overlapping damaged area minimum 150 mm and taping all sides with seam tape.
 - .10 For vapor barrier-safe concrete screeding applications, install vapor barrier-safe screed system per manufacturer's instructions prior to placing concrete.
- .4 Corner details:
 - .1 Double cover outside and inside corners.
 - .2 Use 300 mm wide strip of membrane centered on corner axis.
 - .3 Follow with full width of sheet membrane to cover corner strip completely.
- .5 Construction and Control Joints or Gaps:
 - .1 Ensure that joints are properly sealed with joint sealer and a compatible sealant is installed prior to beginning Work over joint.
 - .2 Install membrane in double thickness over properly sealed joints.
 - .3 Use 300 mm wide strip of membrane centered over joint.
 - .4 Follow with 1000 mm width of sheet membrane.
 - .5 Lap horizontal membrane joints:
- .6 Unacceptable conditions include:
 - .1 Fish mouths and folds

- .2 Blisters and bulges.
- .3 Insufficient overlaps.
- .4 Inadequate adhesion.
- .5 Punctures, tears, cuts.
- .6 Other similar defects.

- .7 Membrane Inspection and Repair:
 - .1 Inspect installed membrane thoroughly and immediately make all necessary corrections.
 - .2 Repair misaligned or inadequately lapped seams, punctures or other damage as noted above.
 - .3 Patch of sheet membrane extending minimum 150 mm in all directions from edge of damaged area.
 - .4 Cut out and patch fish mouths.

- .8 Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges or where compatibility with adjacent materials may be in doubt.

- 3.4 Installation at Penetrations
 - .1 Cut membrane to ensure it is installed tight to penetrations.
 - .2 Provide flanged membrane collar around mechanical and electrical penetrations. Flange shall be at plane of surrounding membrane.
 - .3 Apply tape where membrane has been cut to fit around penetrations.

- 3.5 Protection of Finished Work
 - .1 Do not permit adjacent Work to damage Work of this Section.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide self-adhered water resistive vapour permeable membrane in accordance with requirements of the Contract Documents.

1.2 References

- .1 ASTM International (ASTM):
- .1 ASTM D5034 - Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).
 - .2 ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
 - .3 ASTM E96/E96M - Test Methods for Water Vapor Transmission of Materials.
 - .4 ASTM E398 - Standard Test Method for Water Vapor Transmission Rate of Sheet Materials Using Dynamic Relative Humidity Measurement.
 - .5 ASTM E2178 - Standard Test Method for Air Permeance of Building Materials.
 - .6 ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies.
- .2 American Association of Textile Chemists and Colorists (AATCC): ATCC 127 - Test Method for Water Resistance: Hydrostatic Pressure Test.
- .3 International Code Council Evaluation Service, Inc. (ICC-ES): ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers.

1.3 Submittals

- .1 Submit manufacturers' current product data sheets, details and installation instructions for the water-resistive vapor permeable air barrier membrane components and accessories.
- .2 Submit samples of the following:
- .1 Manufacturer's sample warranty
 - .2 Water-resistive vapor permeable air barrier sheet, minimum 8 by 10 inches (203 by 254 mm)
 - .3 Components, minimum 12 inch (305 mm) lengths
 - .4 Membrane flashings
 - .5 Fasteners, clips, strapping, cladding attachment fasteners and masonry ties
 - .6 Sealants

1.4 Quality Assurance

- .1 Single Source: Self-adhered water-resistive vapor permeable air barrier membrane components and accessories must be obtained as a single-source membrane system to ensure total system compatibility and integrity.
- .2 Manufacturer Qualifications
- .1 Manufacturer of specified products listed in this Section to have minimum 10 years of continued experience in the manufacture and supply of highly vapor permeable water resistive air barrier products successfully installed in similar project applications.
 - .2 Manufacturer of specified products listed in this Section to have experienced in-house technical and field observation personal qualified to provide expert technical support.
- .3 Fire Performance Characteristics: Provide water-resistive barrier meeting the following fire-test characteristics.
- .1 Surface-Burning Characteristics: ASTM E84
 - .2 Flame spread index: 5 or less
 - .3 Smoke developed index: 15 or less

- 1.5 Pre-Installation Conference
- .1 Contractor shall convene [one] week prior to commencing work of this section, under provisions of Section 01 31 19 – Project Meetings.
 - .2 Ensure all contractors responsible for creating a continuous plane of water and air tightness are present.
- 1.6 Delivery, Storage and Handling
- .1 Refer to current product manufacturer's literature for proper storage and handling.
 - .2 Deliver materials to the job site in undamaged and original packaging indicating the name of the manufacturer and product.
 - .3 Store roll materials on end in original packaging. Protect rolls from direct sunlight and inclement weather until ready for use.
 - .4 Waste Management and Disposal
 - .1 Separate and recycle waste materials in accordance with contract documents.
- 1.7 Coordination
- .1 Ensure continuity of the fully self-adhered water-resistive vapor permeable air barrier system throughout the scope of this section.
 - .1 Air barrier vapor permeable membrane to include self-adhered air barrier, transition membranes and sealants at penetrations.
 - .2 Drainage plane to include drainage cavity, water resistive barrier and flashings to the exterior.

2. PRODUCTS

- 2.1 Materials
- .1 Primary fully self-adhered air barrier sheet membrane: zero VOC fully self-adhered vapor permeable air barrier sheet membrane consisting of multiple layers of spun-bonded polypropylene tested in accordance with ICC-ES AC38 criteria to meet IBC and IRC requirements for weather resistive barriers having the following properties:
 - .1 Color: manufacturer's standard with allowable UV exposure for 180 days, prior to coverage.
 - .2 Breaking strength and Elongation to ASTM D5034: 88 lbf (391 N), machine direction; 83 lbf (369 N), cross-machine direction.
 - .3 Water Vapor Permeance tested to ASTM E96/E96M, Method B: minimum of 50.45 perms (2886 ng/Pa.s.m²)
 - .4 Water Vapor Permeance tested to ASTM E398: minimum of 52.57 perms (3007 ng/Pa.s.m²)
 - .5 Air Leakage: ≤ 0.00002 cfm/ft² @ 1.57 psf (≤ 0.0001 L/s m² @ 75 Pa) when tested in accordance with ASTM E2178 and < 0.01 cfm/ft² @ 1.57 psf (< 0.01 L/s m² @ 75 Pa) when tested in accordance with ASTM E2357 and. Meets Air Barrier Association of America (ABAA) requirements for "Adhesive Backed Commercial Building Wraps".
 - .6 Water Resistance tested to AATCC 127, 550 mm hydrostatic head for 5 hours: No leakage
 - .7 Application Temperature: Ambient temperature must be above 20 °F (minus 6.7 °C)
 - .8 Surface Burning Characteristics tested to ASTM E84: Class A, Flame-spread index of less than 5, Smoke-developed index of less than 15
 - .9 Physical Dimensions: 0.022 inches (0.56 mm) thick and 59 inches (1.5 m) wide and 7.58 oz/yd² (257 g/m²).

- .2 Acceptable Materials:
 - .1 Henry Blueskin VP160
 - .2 GCP Applied Technologies, Perm-A-Barrier VPS
 - .3 IKO Aqua Barrier VP
 - .4 Soprema Sopraseal stick VP
 - .5 Resista Red Zone Stick VP
 - .6 Protecto Wrap PW 100/40
 - .7 Vapro Shield, Wrap Shield SA
 - .8 Air-Shield SMP by WR Meadows
 - .9 Tremco EXOAir 430 or 330
 - .10 Perm-A-Barrier VPS as manufactured by GCP Applied Technologies.
 - .11 3M 3015VP

- .3 Thru-wall Flashing membrane (self-adhering type). One of the following approved equals and associated accessories:
 - .1 Perm-A-Barrier WF as manufactured by GCP Applied Technologies.
 - .2 Tremco ExoAir TWF
 - .3 CCW-705-TWF as manufactured by Carlisle
 - .4 Blue Skin TWF as manufactured by Henry Inc.
 - .5 IKO Aquabarrier TWF
 - .6 Soprema Sopraseal WFM or 1100HT
 - .7 Air-Shield TWF by WR Meadows
 - .8 3M 3015 TWF
 - .9 Note that only one type is to be used throughout the project.

3. EXECUTION

3.1 General

- .1 Verify that surfaces and conditions are ready to accept the work of this section. Notify consultant in writing of any discrepancies. Commencement of the work or any parts thereof shall mean acceptance of the prepared substrates.
- .2 All surfaces must be dry, sound, clean, free of oil, grease, dirt, excess mortar or other contaminants detrimental to the adhesion of the water resistive air barrier membrane and flashings. Fill voids and gaps in substrate greater than $\frac{7}{8}$ inch in width to provide an even surface. Strike masonry joints full-flush.
- .3 Minimum application temperature of fully self-adhered membrane and flashings to be above 20 °F (minus 6.0 °C).
- .4 Ensure all preparatory Work is complete prior to applying primary fully self-adhered vapor permeable air barrier sheet membrane.
- .5 Mechanical fasteners used to secure sheathing surfaces or penetrate sheathing surfaces shall be set flush with sheathing, fastened into solid backing and covered with the upper overlapping membrane. If exposed fasteners are present on the surface of the membrane, cover and seal with manufacturer recommended material.

3.2 Coordination of Self-Adhered Vapor Permeable Air Barrier Membrane Installation

- .1 Download Installation Instructions from manufacturer.
- .2 Installation Summary:
 - .1 Self-adhered vapor permeable air barrier sheets may be installed vertically or horizontally over the outside face of exterior sheathing board or other approved substrates.
 - .2 Complete detail work at; wall openings, building transitions and penetrations prior to field applications.

- .3 Install fully self-adhered vapor permeable air barrier sheet over the outside face of exterior sheathing board or substrate, measure and pre-cut into manageable sized sheets to suit the application conditions.
- .4 Install fully self-adhered vapor permeable air barrier sheet complete and continuous to substrate in a sequential minimal 3 inch (76 mm) overlapping weatherboard.
- .5 Stagger all end lap seams.
- .6 Roll installed membrane with roller to ensure positive contact and adhesion with substrate immediately.

3.3 Building Transition Conditions

- .1 Tie-in to structural beams, columns, floor slabs and intermittent floors, parapet curbs, foundation walls, roofing systems and at the interface of dissimilar materials with self-adhering air barrier transition and flashing membrane.
- .2 Align and position fully self-adhered air barrier transition and flashing membrane, remove protective film and press firmly into place. Provide minimum 3 inch (76 mm) lap on to substrates.
- .3 Ensure minimum 3 inch (76 mm) overlap at side and end laps of membrane and 6 inch (152.4 mm) at inside and outside corners, if joints occur at corner locations.
- .4 Roll membrane and lap seams with roller to ensure positive contact and adhesion, immediately.

3.4 Vertical Applications Summary

- .1 For vertical applications, align sheets with an 'inside' or 'outside' corner to avoid wrinkles and misalignment of subsequent applications.
- .2 Measure and pre-cut into manageable sized fully self-adhered sheets to suit the application conditions.
- .3 Allow for excess material at bottom of wall to accommodate tie-ins and connections to adjacent surfaces.
- .4 Roll up pre-cut material lengths with release paper facing OUTWARD.
- .5 Starting at a corner of the roll, peel back approx. 6" (152.4 mm) of release film from across the width of the pre-cut material roll.
- .6 Using hand pressure, lightly apply the exposed adhesive surface to the substrate.
- .7 Allow the rolled up material to drop down the wall, with the remainder of the release film still attached (facing the wall), and extend down to lowest point of wall, checking for proper alignment, repositioning as necessary.
- .8 Allow for excess material at bottom of wall to accommodate tie-ins and connections to adjacent surfaces.
- .9 Align and position fully self-adhered membrane, remove release film and press firmly into place. Provide minimum 3 inch (76 mm) overlap at side and end laps of membrane.
- .10 Continue to remove release film and apply pressure to ensure positive contact onto wall substrate.
- .11 Install subsequent sheets of fully self-adhered vapor permeable air barrier sheets in overlapping weatherboard format. Ensure sheets lay smooth and flat to surfaces. Roll membrane and lap seams with two handed roller to ensure contact and adhesion.

3.5 Fastening Clips and Masonry Ties

- .1 Install clips and masonry ties over primary self-adhered vapor permeable air barrier membrane.

- .2 Secure clips and masonry ties with corrosion-resistant, or stainless steel screws with gasketed fasteners.
- 3.6 Field Quality Control
- .1 Make notification when sections of work are complete to allow review prior to covering fully self-adhered water-resistive vapor permeable air barrier system.
 - .2 Owner to engage independent consultant to observe substrate and membrane installation prior to placement of cladding system(s) and provide written documentation of observations.
- 3.7 Protection
- .1 Protect wall areas covered with self-adhered water-resistive vapor permeable air barrier from damage due to construction activities, high wind conditions, and extended exposure to inclement weather.
 - .2 Review condition of fully self-adhered water-resistive vapor permeable air barrier prior to installation of cladding. Repair, or remove and replace damaged sections with new membrane.
 - .3 Recommend to cap and protect exposed back-up walls against wet weather conditions during and after application of membrane, including wall openings and construction activity above completed fully self-adhered water-resistive vapor permeable air barrier installations.
 - .4 Remove and replace water-resistive weather barrier membrane affected by chemical spills or surfactants.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide metal wall cladding system in accordance with requirements of the Contract Documents.

1.2 References

- .1 ASTM International (ASTM):
- .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .2 ASTM A755/A755M, Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
 - .3 ASTM A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
- .2 Canadian Sheet Steel Building Institute (CSSBI):
- .1 CSSBI 20M, Standard for Sheet Steel Cladding for Architectural, Industrial and Commercial Building Applications

1.3 Delegated Design Requirements

- .1 Submit letters of commitment and compliance indicating engineering scope of work undertaken by this Section.

1.4 Performance Requirements

- .1 Maximum deflection not to exceed $L/180$ under system's own weight plus wind load (positive and negative) loads acting normal to the plane in accordance with the Building Code Climatic Data, wind load 1:30 years.
- .2 Calculate live load deflections in accordance with CSSBI 20M, as modified by the requirements of this Section.
- .3 Provide for movement of components without causing buckling, failure of joint seals, undue stress on fasteners when subject to seasonal temperature range from -40°C (-40°F) to $+50^{\circ}\text{C}$ (120°F), and wind loads noted in 1.4.1 above.
- .4 Include expansion joints to accommodate movement in wall system and between wall system and building structure, where these movements are caused by deflection of building structure, and accommodate these movements, without permanent distortion, damage to infills, racking of joints, breakage of seals, or water penetration.
- .5 Provide for positive drainage to the exterior of all water entering or condensation occurring within the system.

1.5 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
- .1 Submit manufacturer's product specifications, standard details, certified product test results, and general recommendations, as applicable to materials and finishes for each component and for total panel assemblies.
- .2 Manufacturer's Standard Drawings: Furnish drawings indicating layouts of panels, details of corner conditions, joints, panel profiles, supports, anchorages, trim, flashings, closures, and special details, distinguishing between factory and field assembled.

- .1 Include structural analysis data signed and sealed by a professional engineer responsible for their preparation of shop drawings for installed products indicated to comply with design loadings listed above.
- .3 Submit samples of materials as follows:
 - .1 Provide sample panels 305 mm (12") long x actual panel width in specified profile, style, colour, and texture including clips, caps, battens, fasteners, closures, and other exposed panel accessories for verification and acceptance by the Consultant.
- .4 Closeout Submittals: Submit for Owner's documentation.
 - .1 Furnish the specified warranty.
- 1.6 Delivery, Storage and Handling
 - .1 Deliver materials so they will not be damaged or deformed.
 - .2 Package materials for protection against damage during transportation or handling.
 - .3 Exercise care in unloading, storing, and erecting wall system to prevent bending, warping, twisting, and surface damage.
 - .4 Stack materials on platforms or pallets, covered with tarpaulins or other suitable weather tight and ventilated covering, maintaining wall system in a dry condition.
 - .5 Do not store materials in contact with other materials that might cause staining, denting, or other surface damage.
- 1.7 Project Conditions
 - .1 Verify location of structural members and openings in substrates by field measurements before fabrication and indicate measurements on shop drawings, coordinate fabrication schedule with construction progress to avoid delaying the work.
 - .2 Where field measurements cannot be made without delaying the Work, either establish opening dimensions and proceed with fabricating wall system without field measurements or allow for trimming panel units on site, coordinate wall construction to ensure actual locations of structural members and to ensure opening dimensions correspond to established dimensions.
- 1.8 Pre-Installation Conference
 - .1 Convene one (1) week before commencing Work of this Section to discuss expectations for fit and finish of wall system, quality of workmanship for installation of air/vapour retarders and insulation and relationship of wall system to adjacent components.
 - .2 Meeting shall be attended by the installer, manufacturer's representative, and General Contractor.
 - .3 Manufacturer's representative shall also provide frequent inspection visits during the course of work of this Section to assure quality and competence of membrane installation and panel alignment.
- 1.9 Coordination
 - .1 Coordinate work of this section with the requirements of Section 07 62 00, for specific requirements for supply of prefinished sheet metal flashing materials to other sections of the work as follows:
 - .1 Supply prefinished sheet metal flashings required for the project, regardless of sheet metal thickness and colour.
 - .2 Provide prefinished sheet metal flashings to installing trades, tension levelled and guillotine sheared to length ready for brake forming, fabrication and installation by installing trades.

- .3 Coordinate with installing trades during bid period and provide unit prices for materials based on specified thickness and colour of flashing materials required under their respective scopes of work; installing trades will be responsible for carrying cost for flashing materials in their scope of work in their Bid Price.
- .4 Requirements of this portion of the scope of work do not apply to extruded aluminum or other pre-manufactured flashing materials normally supplied by installing trades (i.e.: extruded aluminum curtain wall flashing and sills, preformed roof penetrations, non-prefinished sheet metal products).
- .5 Sub Contractor responsible for supply of metal wall and soffit cladding will only be responsible for fabrication and installation of flashings relating to their scope of work.

2. PRODUCTS

2.1 Cladding Materials

- .1 Zinc Galvanized Sheet Steel Cladding: Tension levelled, Commercial Steel (CS) designation, Type A, Grade 230 (33) in accordance with ASTM A653/A653M and as follows:
 - .1 Thickness: Minimum 0.76 mm (0.030") base metal thickness, or thicker as required to meet design loads.
 - .2 Galvanizing Designation: Z275 (G90) applied evenly to both sides.
 - .3 Metal Cladding: Surface Texture: Smooth; and as follows:
 - .1 Type 2: Profile: to match VicWest AD300; natural zinc
 - .2 Type 2: Profile: to match Westform WF-WF - locations indicated on Drawings.
 - .3 Type 3: Profile: to match Forma Steel – Forma Loc 406 mm metal cladding, colour white.
 - .4 Type 4: profile to match Tradiational Panel metal cladding, Autumn.
 - .5 Type 5: metal cladding – charcoal.
 - .4 Finish: Baycoat Perspectra Series or Vicwest Weather-X, colour as selected by Consultant, or as indicated on Drawings.

2.2 Finishing

- .1 Coil Coated Materials: Prefinished materials coated to film thickness as recommended by coating manufacturer, and designed specifically for vertical surfaces to 30° from vertical, and horizontal surfaces 5° up to 60° from horizontal, acceptable colours and materials and in accordance with ASTM A755/A755M.

2.3 System Components

- .1 Strapping: as detailed, to sizes indicated on Drawings. Refer to Section 06 10 00.
- .2 Vertical Channels: Fabricated from minimum 1.21 mm (0.047") base metal thickness galvanized steel to ASTM A653/A653M, Grade 230 with Z275 (G90) coating; finish material visible after assembly of wall panel shall be finished to match aluminum panels.
- .3 Isolation Tape: Manufacturers standard material for separating dissimilar metals from direct contact.
- .4 Flashing, Trim and Enclosure: Core material, thickness, and finish to match cladding material.
- .5 Panel Fastenings: Manufacturer's standard to suit design loads and application. Finish all exposed fasteners to match metal panels; self-tapping screws, bolts, nuts, self-locking rivets and bolts, end welded studs, and other suitable fasteners designed to withstand design loads, and as follows:
 - .1 Use stainless steel fasteners for exterior applications and galvanized steel fasteners for interior applications.
 - .2 Provide exposed fasteners with heads matching colour of panel by means of plastic caps or factory-applied coating; keep exposed fasteners to a minimum.

- .3 Provide metal backed neoprene washers under heads of exposed fasteners located on weather side of panels.
- .6 Insulation Fastenings: Corrosion resistant, galvanized bugle head screws with 38 mm (1½") diameter washer, 25 mm (1") minimum penetration into wall framing.
- .7 Closure Strips: Closed cell, self extinguishing, expanded, cellular, rubber or cross linked, polyolefin foam flexible closure strips, cut or pre-moulded to match configuration of cladding to maintain weather tight construction.
- .8 Sealing Tape: Pressure-sensitive, 100% solids, polyisobutylene compound sealing tape with release paper backing; permanently elastic, non-sag, non-toxic, non-staining.
- .9 Sealant: One-part elastomeric polyurethane, polysulphide, or silicone rubber sealant as recommended by panel manufacturer in accordance with Section 07 92 00, type as recommended by manufacturer for specific end use, colour to match cladding where exposed.
- .10 Accessories: Provide components required for a complete wall cladding assembly including trim, copings, fascia, mullions, sills, corner units, clips, seam covers, flashings, louvers, sealants, gaskets, fillers, closure strips, and similar items; to match materials and finishes of panels.
- .11 Bituminous Coating: Cold-applied asphalt mastic, in accordance with CGSB 1.108, compounded for 0.40 mm (15 mil) dry film thickness per coat with inert type non-corrosive compound free of asbestos fibres, sulphur components, and other deleterious impurities.

2.4 Fabrication

- .1 Fabricate and finish cladding, and accessories at the factory to greatest extent possible using manufacturer's standard procedures and processes, and conforming to indicate profiles and with dimensional and structural requirements.
- .2 Fabricate panels true, plumb and square, with no oil-canning or deformity that detracts from aesthetic appearance.
- .3 Apply bituminous coating or other permanent separation materials on concealed panel surfaces where cladding will be in direct contact with substrate materials that are not compatible or could result in corrosion or deterioration of either materials or finishes.

3. EXECUTION

3.1 Examination

- .1 Obtain dimensions from job site before fabricating wall system.
- .2 Examine substrates for conditions affecting performance of metal cladding and correct unsatisfactory conditions, or notify Contractor for correction of conditions not controlled by this Section.
- .3 Do not proceed with wall panel installation until unsatisfactory conditions have been corrected.
- .4 Inspect wall system and components before installation and verify that there is no shipping damage.
- .5 Do not install damaged panels; repair or replace as required for smooth and consistent finished appearance.

3.2 Preparation

- .1 Coordinate metal wall system installation with rain drainage work; flashing; trim; and construction of soffits, roofing, parapets, walls, and other adjoining work to provide a leak-proof, secure, and non-corrosive installation.
- .2 Promptly remove protective film, if any, from exposed surfaces of metal panels. Strip with care to avoid damage to finish.
- .3 Install girts, angles, and other secondary structural panel support members and anchor according to reviewed shop drawings and manufacturer's written instructions.
- .4 Install air and vapour retarder membrane, and insulation in accordance with manufacturer recommendations. Use primer where manufacturer recommends primer.

3.3 Cladding Installation

- .1 Comply with panel manufacturer's written instructions and recommendations for installation, as applicable to project conditions and supporting substrates.
- .2 Anchor wall system and other components of the work securely in place, with provisions for thermal and structural movement, and as follows:
 - .1 Field cutting exterior cladding by torch is not permitted.
 - .2 Install cladding with fasteners as detailed. Exposed fasteners to match panel finishes.
 - .3 Locate and space exposed fasteners in true vertical and horizontal alignment. Use proper tools to obtain controlled, uniform compression for positive seal without rupture of neoprene washer.
- .3 Install accessories as required for a complete wall panel assembly including trim, copings, fascia, mullions, sills, corner units, clips, seam covers, flashings, louvers, sealants, gaskets, fillers, closure strips, and similar items.
- .4 Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of wall panel assemblies of types indicated or, if not otherwise indicated, types recommended by panel manufacturer and as follows:
 - .1 Flash and seal cladding at ends and intersections with other materials with rubber, neoprene, or other closures to exclude weather.
 - .2 Seal panel end laps with a bead of tape or sealant, full width of panel.
 - .3 Seal side joints where recommended by panel manufacturer.
 - .4 Prepare joints and apply sealants to comply with requirements of Section 07 92 00.
- .5 Wall Cladding: Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, as required for waterproofing in accordance with sealant manufacturer's written instructions, and as follows:
 - .1 Align bottom of wall cladding and fasten with blind rivets, bolts, or self-tapping screws.
 - .2 Fasten flashings and trim around openings and similar elements with self-tapping screws.
 - .3 Install screw fasteners with power tools having controlled torque adjusted to compress neoprene washer tightly without damage to washer, screw threads, or panels.
 - .4 Install screws in predrilled holes.
 - .5 Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- .6 Separate dissimilar metals by painting each metal surface in area of contact with a bituminous coating or by other permanent separation as recommended by manufacturers of dissimilar metals.
- .7 Installation Tolerances: Shim and align cladding system within installed tolerance of 6 mm (1/4") in 6'100 mm (20'-0") on level, plumb, and location lines as indicated, and within 3 mm (1/8") offset of adjoining faces and of alignment of matching profiles.

3.4 Cleaning and Protection

- .1 Damaged Units: Replace cladding and other components of the Work that have been damaged or have deteriorated beyond successful repair by finish touch-up or similar minor repair procedures.
- .2 Cleaning: Remove temporary protective coverings and strippable films, if any, as soon as each panel is installed. On completion of panel installation, clean finished surfaces as recommended by panel manufacturer and maintain in a clean condition during construction.

3.5 Field Quality Control

- .1 The manufacturer's representative, the Contractor and Consultant shall carry out final inspection and approval of completed Work.
- .2 Deficiencies will be noted and corrections made before acceptance of Declaration for Substantial Performance.

END OF SECTION

1. GENERAL

1.1 Section Includes

- .1 Tongue and Groove siding and soffits.

1.2 References

- .1 Western Red Cedar Lumber Association "Designer's Handbook".
- .2 Western Red Cedar Lumber Association "Specifying Cedar Siding".
- .3 Western Red Cedar Lumber Association "How to Installing Cedar Siding".
- .4 Western Red Cedar Lumber Association "Guide to Finishing Western Red Cedar".
- .5 NLGA - National Lumber Grades Authority "Grading Standards".

1.3 Submittals

- .1 Product Data: Western Red Cedar Lumber Association's data sheets on each product to be used, including:
 - .1 Preparation instructions and recommendations.
 - .2 Storage and handling requirements and recommendations.
 - .3 Installation methods.
- .2 Verification Samples: For each finish product specified, three samples, nominal size 5 1/2 inches (140 mm) square representing actual product with finished color and texture.

1.4 Quality Assurance

- .1 Manufacturer Qualifications: Manufacturer shall be a member of the Western Red Cedar Lumber Association capable of providing all Western Red Cedar siding materials specified in this section.
- .2 Installer Qualifications:
 - .1 Installer shall have experience installing cedar trim on the type and size of project specified by this section.
 - .2 Installer shall be licensed, registered or otherwise approved by the local jurisdiction to install Cedar Siding.
 - .3 Installation: Products shall be installed according to Western Red Cedar Lumber Association installation guidelines and adhere to local building codes.

1.5 Delivery, Storage and Handling

- .1 Inspect the materials upon delivery to assure that specified products have been received.
- .2 Store materials in safe area, away from construction traffic; store under cover and off ground, protected from moisture.
- .3 Keep materials clearly separated and identified with grade marks legible. Keep damaged material identified as damaged and stored separately.

1.6 Project Conditions

- .1 Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.7 Supplemental Materials

- .1 Fasteners, supports, and hangers shall be provided by manufacturers other than member organizations of the WRCLA, and conform to the requirements set forth by this section.

2. PRODUCTS

2.1 Manufacturers

- .1 Acceptable Manufacturer: Western Red Cedar Lumber Association, which is located at: 1501 - 700 W. Pender St. Pender Place 1, Business Bldg. ; Vancouver, BC, Canada V6C 1G8; Toll Free Tel: 866-778-9096; Tel: 604-684-0266; Email: [request info \(wrcla@wrcla.org\)](mailto:request_info@wrcla.org); Web: www.wrcla.org

2.2 Fins

- .1 Clear Cedar Fins: Western Red Cedar graded to meet NLGA "Grading Standards," paragraph 200.
 - .1 Grade: A Clear
 - .2 Pattern: 89 x 184 mm planks, channel profile, flush joints.
 - .3 Texture: Smooth faced.
 - .4 Moisture Content: Kiln-dried.
 - .5 Finish: stain as selected by Consultant.
- .2 Use wood products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of project site.

2.3 Fasteners

- .1 Nails: Material: No. 304 stainless steel.
- .2 Type: Splitless Siding Nails for siding and soffits.
- .3 Length: Must be sufficient to penetrate solid wood a minimum of 1 1/4"

2.4 Finishing

- .1 Stain to match longboard cladding. Refer to Elevations for longboard colour, and refer to Section 09 91 00 for stain finishing.

3. EXECUTION

3.1 Preparation

- .1 Coordinate work with related trades; scribe and cope siding boards for accurate fit. Allow installation of related work to avoid cutting and patching.
- .2 Select siding boards of longest possible lengths. Discard boards that are warped, twisted, bowed, crooked or otherwise defective.

3.2 Installation

- .1 Follow installation instructions specified in the Western Red Cedar Lumber Association's Installing Cedar Siding publication and DVD.
- .2 Installation must comply with local building codes and regulations.
- .3 Finish materials on all sides and ends. Apply touch up coating on new cuts. Factory primed or finishing is preferred.

3.3 Adjusting and Cleaning

- .1 As work proceeds, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris related to this work.

3.4 Maintenance

- .1 Explain proper maintenance procedures to owner or owner's representative at project closeout.
- .2 Visually inspect siding, caulking, flashing annually for overall condition. Re-apply caulking and coating as necessary. Adjust flashing as required.
- .3 The use of pressure washers is not recommended.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 This Section includes requirements for supply and installation of fibre reinforced cement panels.
- .2 Indicated on Drawings as Fibre Cement Panels.

1.2 Reference Standards

- .1 The reference documents listed below form an integral part of this specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision /edition published at the effective date of the contract.
- .2 ASTM International (ASTM):
 - .1 ASTM C 1185 - 08 Standard Test Methods for Sampling and Testing NonAsbestos Fibre-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards.
 - .2 ASTM C 1186 - 08 Standard Specification for Flat Fibre-Cement Sheets.
 - .3 ASTM E 119 - 12a Standard Test Methods for Fire Tests of Building Construction and Materials
 - .4 ASTM E2226-12 Standard Practice for application of Hose Stream
 - .5 ASTM G 155-05a, Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
 - .6 ASTM D 2244-09a, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
 - .7 AISI S905-08, Test Methods for Mechanically Fastened Cold-Formed Steel Connections
- .3 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC S114, Standard Method of Test for Determination of Non-Combustibility in Building Materials

1.3 Submittals

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
 - .1 Product Data: Submit product data indicating construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated, in addition to the following specific requirements:
 - .1 Mechanical Fasteners: Indicate sizes, shear, and pull over loading capacity where applicable.
 - .2 Corrosion Protection: Indicate thickness and type of corrosion protection coating.
 - .2 Shop Drawings: Submit shop drawings prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of Fibre Reinforced Cement Panels clearly indicating all construction details including; but not limited to, the following:
 - .1 Connections and anchor requirements
 - .2 Type, size and spacing of fastening devices; hidden fasteners
 - .3 Design loads
 - .4 Connections to adjacent air and vapour membranes
 - .5 Internal drainage
 - .6 Sealant locations
 - .7 Seal of a professional engineer registered in the Province of the Work for details requiring structural design for load bearing, or life/health safety.
- .2 Informational Submittals: Provide the following:

- .1 Qualification Statement: Submit evidence of welder qualifications specified in this Section when requested by Consultant.
- .2 Source Quality Control Submittals: Submit delegated design professional engineer's design notes and calculations upon request of the Consultant.

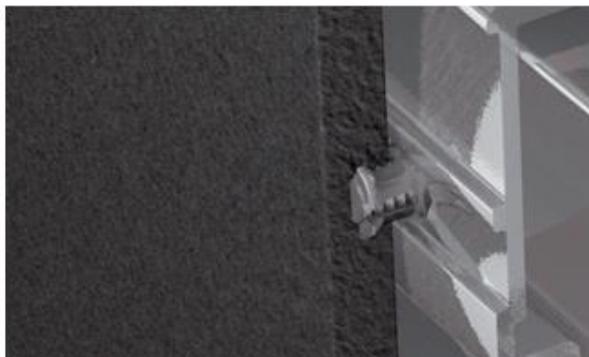
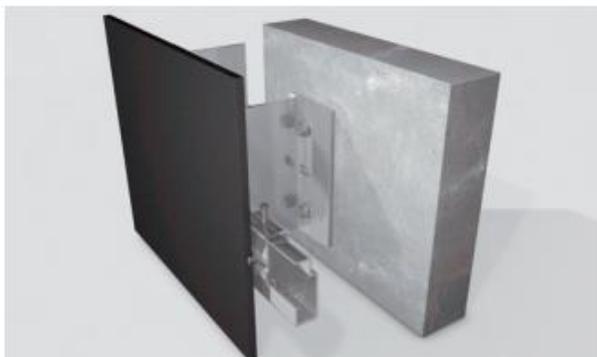
2. PRODUCTS

2.1 Manufacturers

- .1 Basis-of-Design: Equitone
- .2 Fibre Cement Panels: Glassfibre reinforced concrete panel, classified as non-combustible in accordance with ULC S114, not to exceed 5 PSF and having the following characteristics:
 - .1 Size: 2500 mm x 1200 mm unless indicated otherwise.
 - .2 Thickness: 12 mm based on weight limit to panel and support system of 5lbs / sq.ft.
 - .3 Fasteners: Concealed Mechanical Fastening
 - .4 Colour: refer to Drawings.
 - .5 Finish: Refer to Drawings.
 - .6 Joints to be 10 mm open joints, in which there is a clear open gap between the edges of adjoining panels. Include metal closure strips to cover gaps between panels

2.2 System Back-Up Materials

- .1 Girts: Fabricated from minimum 1.27 mm thickness galvanized steel to ASTM A653/A653M, Grade 230 with Z275 coating; finish material visible after assembly of wall panels.
- .2 Fastening System: Manufacturer's Concealed fastening with undercut anchor.



2.3 Accessories

- .1 Flashing: Provide pre-finished, galvanized sheet steel flashing or aluminum and trims in accordance with Section 07 62 00, at window and door heads and where indicated, colour and material to match adjacent opening material.
- .2 Elastomeric Joint Sealant: Two - part multi-component sealant joint sealant in accordance with Section 07 92 00.

- .3 Fasteners: manufacturer's standard fastening system as detailed.

3. EXECUTION

3.1 Examination

- .1 Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of siding.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Preparation

- .1 Clean substrates of projections and substances detrimental to application.

3.3 Installation

- .1 Install girt system to meet panel manufacturer requirements.
- .2 Coordinate installation of insulation and girt system with panel manufacturer.
- .3 Install panels in accordance with manufacturer's written installation instructions applicable to products and applications.
- .4 Finish exposed cut ends with matching colour and paint.
- .5 Install panel system in accordance with manufacturer's instructions and approved Shop Drawings.
- .6 Install metal trim:
 - .1 Vertical panel-to-panel joints: Install Vertical Trim indicated on Drawings
 - .2 Horizontal panel-to-panel joints: Install Horizontal Trim indicated on Drawings.
 - .3 Inside corners: Install Inside Corner Trim.
 - .4 Outside corners: Install Outside Corner Trim.
 - .5 Over openings in walls and at bottom of walls: Install Drip Cap Trim.
- .7 Fasten trim at maximum 600 mm on center.
- .8 Leave 13 mm gap between horizontal drainage flashings and bottom of panel above. Do not seal this space.
- .9 Allow minimum vertical clearance between edge of panel system and adjacent materials in accordance with manufacturer's instructions.
- .10 Cut panels to fit around penetrations with maximum 6 mm gaps. Smooth and seal cut edges.
- .12 Fasten panel system at maximum spacing per manufacturer's Code compliance reports. Place fasteners exposed, minimum 10 mm from panel edges and 50 mm from top and bottom edges at panel corners, in orderly fastening pattern.
- .13 Apply joint sealer between panel system and adjacent surfaces as specified in Section 07 92 00 except at horizontal drainage flashings.

3.4 Adjusting and Cleaning

- .1 Remove damaged, improperly installed, or otherwise defective siding materials and replace with new materials complying with specified requirements.
- .2 Clean finished surfaces according to siding manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide metal siding, in accordance with requirements of the Contract Documents.

1.2 References

- .1 AA, "Aluminum Association".
- .2 AAMA 2605, Voluntary Specification, Performance requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- .3 AAMA 2604, Voluntary Specification, Performance requirements and Test Procedures for High Performing Organic Coatings on Aluminum Extrusions and Panels.
- .4 AAMA 2603, Voluntary Specification, Performance requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.

1.3 Submittals

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
- .1 Shop Drawings: Submit shop drawings showing assembly and installation details, method of sealing and flashing, building connection attachments, provision for thermal movement, and static release loads and static release forces.
- .2 Samples:
- .1 Section of pre-formed metal siding and soffit systems, minimum size 450 mm x 450 mm, showing pre-formed corner, vertical joint for horizontal surface.
- .2 Metal cladding / siding, in selected colour on actual metal base.

1.4 Performance Requirements

- .1 Maximum deflection not to exceed L/180 under system own weight plus wind and suction loads acting normal to plane in accordance with Building Code Climatic Data, wind load 1:30 years.
- .2 Provide movement of components without causing buckling, failure of joint seals, undue stress on fasteners when subject to seasonal temperature range, from -40°C to 50°C, and preceding noted wind and suction loads.
- .3 Include expansion joints to accommodate movement in system and between soffit system and building structure and , where these movements are caused by deflection of building structure. Accommodate these movements, without permanent distortion, damage to infills, racking of joints, breakage of seals, or water penetration.
- .4 Provide for positive drainage to exterior of all water entering or condensation occurring within system.
- .5 Field Quality Control:
- .1 The manufacturer's representative and Contractor shall carry out final inspection and approval of completed Work.

1.5 Delivery, Storage And Handling

- .1 Cover pre-finished components to protect surface finishes and insulation core from damage and deterioration.
- .2 Store components off ground to prevent twisting, bending or delamination. Slope to shed moisture.

2. PRODUCTS

2.1 Materials

- .1 Prefinished Aluminum-Zinc Alloy Coated Steel Sheet, 0.635 mm ASTM 792, Grade 40, yield strength 40 ksi min.

2.2 Siding Panel – Wood Grain

- .1 Extruded Aluminum Siding and Soffits: Wood Grain Aluminum Siding and Soffits with Alluminate bonded film finish is extruded aluminum with integrated venting system.
 - .1 Size: 100 mm V-groove.
 - .2 Finish: woodgrain As selected from manufacturer's standard range.
 - .3 Basis of Design: Longboard Soffits and Siding

2.3 Accessory Materials

- .1 Accessories: Prefinished aluminum, to match panels, and starter strips as recommended by manufacturer.
- .2 Fasteners: as recommended by manufacturer.
- .3 Sealant: Refer to Section 07 92 00.
- .4 Thermally broken back framing system: as recommended by manufacturer for siding and soffit installation.

2.4 Fabrication

- .1 All exposed adjacent flashing of the same material and finish as roof panels.
- .2 Hem all exposed edges of flashing on underside, 12.70 mm.
- .3 Prepare surfaces, pre-treat and coat components in accordance with AAMA 2604 and 2605 Quality Standards and applicable European standards for the coating material specified.
- .4 Wrap and package coated components using methods suitable for transit and covered site storage without damage.

2.5 Finish

- .1 Super Durable Powder Coatings: Alluminate Premium Wood Finishes use a polyurethane powder coat with ink based wood grain patterns sublimated into the base powder effectively tattooing the powder. The combined effect creates all the aesthetic aspects of real wood while offering the same environmental advantages of powder coated finishes.
- .2 Wood Grain as selected by Consultant from manufacturer standard finishes.

3. EXECUTION

3.1 Preparation

- .1 Obtain dimensions from job site.
- .2 Ensure structural support is aligned and condition is acceptable.
- .3 Provide additional structural framing as may be required to conform to Performance Requirements.

3.2 Installation

- .1 Install in accordance with manufacturer's written instructions and Contract Documents, plumb, true, level, and rigid.
- .2 Install siding and soffit panels to structural support by hidden mechanical fasteners.
- .3 Install support girts, as required, to structural support. Interlock and seal side and end joints.
- .4 Place insulation between Larson truss to cover complete wall area, full thickness as indicated. Refer to Drawings for details.
- .5 Install flashings to divert all moisture and condensation to exterior.
- .6 Install pre-formed corners and end enclosures, caulked and sealed to arrest direct weather penetration.
- .7 Ensure panels aligned vertically and horizontally.
- .8 Barrier Protection: Do not install over cementitious materials, dissimilar metals or pressure treated material without adequate barrier protection.
 - .1 Install building paper horizontally on walls to receive metal siding.
 - .2 Weather lap edges 6 inches (150 mm) and ends minimum 6 inches (150 mm).
 - .3 Stagger vertical joints of each layer.
 - .4 Securely staple, nail in place.
- .9 Fasten siding to structural supports; aligned, level, and plumb.
- .10 Locate joints over supports.
- .11 Install expansion control joints where indicated.
- .12 Use concealed fasteners.

3.3 Adjusting And Cleaning

- .1 Remove all excess materials, debris and equipment at completion.
- .2 Clean all panels clean and free of all grime and dirt.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide SBS modified bituminous membrane roofing system in accordance with requirements of the Contract Documents.

1.2 References

- .1 ASTM International (ASTM):
- .1 ASTM C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
 - .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 37.50, Hot-Applied, Rubberized Asphalt for Roofing and Waterproofing. (withdrawn)
 - .3 Alberta Roofing Contractors Association (ARCA)
 - .1 Roofing Applications Standards Manual.
 - .4 CSA Group (CSA)
 - .1 CSA A123.21, Standard test method for the dynamic wind uplift resistance of membrane-roofing systems
 - .5 Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .6 Underwriters Laboratories' of Canada (ULC)
 - .1 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .2 CAN/ULC-S704, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.

1.3 Administrative Requirements

- .1 Convene pre-installation meeting one week prior to beginning waterproofing Work, with roofing contractor's representative and Consultant to:
- .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.4 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
- .1 Furnish technical data describing the quality and performance of each material component or system to be used in the Work, e.g., the fire classification, U value or other such characteristics as required by the drawings or specifications.
 - .2 Submit copies of the most current technical data sheets describing physical properties of materials, and explanations about product installation, including installation techniques, restrictions, limitations and other manufacturer recommendations.
 - .3 Submit membrane manufacturer's standard details that will be utilized for this project, indicate changes that must be made to make the details project specific for review by the Consultant.
- .2 Shop Drawings: Submit for Consultant's action. Indicate tapered insulation details. Provide layout for tapered insulation.

- .3 Informational Submittals: Submit for Consultant's action.
 - .1 Certificates:
 - .1 Manufacturer's Certificate: certify that products meet or exceed specified requirements.
 - .2 Submit certification from an independent testing laboratory experienced in testing rubberized asphalt material stating that material supplied for the Project meets or exceeds the requirements of CGSB 37.50, including ASTM procedures listed within the standard.
 - .3 Submit certification indicating full time quality control of production facilities responsible for manufacture of rubberized asphalt and batch records for tested material indicating conformance to manufacturer's published physical properties.
 - .4 Submit certification indicating that components used in the roof system are supplied and warranted by a single source manufacturer.
 - .5 Submit certification indicating testing roof systems meets testing for windup lift for location and use.
 - .4 Quality Control Submittals: Submit for Consultant's action.
 - .1 Submit maintenance instructions and specified warranty.
 - .2 Maintenance and Operating Manuals: Submit for Owner's documentation. Furnish complete manuals describing the materials, devices and procedures to be followed for the care and maintenance of the Work. Include manufacturers' brochures and lists describing the actual materials used in the Work, including membrane and flashings, insulation.
 - .5 Quality Assurance Submittals: Submit for Consultant's action:
 - .1 Installer qualifications: company or person specializing in application of modified bituminous roofing systems with five (5) years experience approved by manufacturer.
 - .2 At least one member of the roofing crew is to be a 'journeyman roofer' and is to be on site at all times.
 - 1.5 Fire Protection
 - .1 Fire Extinguishers:
 - .1 Maintain one cartridge operated type or stored pressure rechargeable type with hose and shut-off nozzle,
 - .2 ULC labelled for A, B and C class protection.
 - .3 Size 9 kg on roof per torch applicator, within 6 m of torch applicator.
 - .2 Maintain fire watch for a minimum of four (4) hours after each day's torching operations cease with trained, and properly equipped fire watch personnel. Inspections shall include during lunch and coffee breaks Fire watch shall continuously watch and patrol building interior and exterior including roof top inspection. Equipment shall include, in addition to proper personal protective equipment and fire extinguishers, cellular telephones for contacting emergency services should problems occur and infrared scanners to measure temperatures of all roof and structure components to assist in the detection of hot spots. Fire watch personnel shall keep written records of observations and procedures. In addition to the above, comply with all fire watch procedures of the ARCA. Fire watch personnel shall be certified torch technicians as certified by the ARCA.
- 1.6 Delivery, Storage and Handling
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Storage and Handling Requirements:
 - .1 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers and caulking materials.
 - .2 Provide and maintain dry, off-ground weatherproof storage.
 - .3 Store rolls of felt and membrane in upright position. Store membrane rolls with salvage edge up.
 - .4 Remove only in quantities required for same day use.
 - .5 Place plywood runways over completed Work to enable movement of material and other traffic.
 - .6 Store adhesives and sealants at +20 degrees C minimum.
 - .7 Store insulation protected from weather and deleterious materials.
- 1.7 Field Conditions
 - .1 Ambient Conditions
 - .1 Do not install roofing when temperature is below -10°C, or to manufacturers' recommendations.
 - .2 Minimum temperature for solvent-based adhesive is -10°C.
 - .2 Install roofing on dry deck, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into roofing system.
- 1.8 Warranty
 - .1 The product manufacturer will issue a written and signed document in the owner's name, certifying all product performance properties for a period of fifteen (15) years, starting from the date of acceptance. This warranty will cover the removal and replacement of defective roof membrane products, including labour. The warranty must remain a full warranty for the duration of the period specified. The scope of this warranty must not be limited by other system components manufactured or distributed by the membrane manufacturer. No letter amending the manufacturer's standard warranty will be accepted and the warranty certificate must reflect these requirements.
 - .2 The contractor will provide a warranty for this project, valid for a period of two (2) years covering labour, materials and workmanship for entire area of re-roofing project.
 - .3 Warranties are to be "no dollar limit" (NDL) and are cover all labour, materials and workmanship for the periods outlined.
 - .4 Warranty is to commence upon substantial completion of the Work.
 - .5 Warranty must be transferable, at no extra cost, to subsequent building owners.
- 2. PRODUCTS**
 - 2.1 Performance Criteria
 - .1 Compatibility between components of roofing system is essential. Provide written declaration to independent building envelope inspector stating that materials and components, as assembled in system, meet this requirement.
 - 2.2 Acceptable Manufacturer's/Systems
 - .1 Manufacturers: All membrane components to be supplied by a single manufacturer where possible. Submit complete proposed material list for all roof membrane assembly components to the independent building envelope inspector for review and approval prior to the roofing project start-up meeting.

2.3 Primer

.1 Primers:

.1 Description: a primer designed to enhance the adhesion of self-adhesive membranes on porous surfaces at temperatures above -10 degrees C. Acceptable products:

- .1 Firestone
- .2 IKO SAM Adhesive
- .3 SOPREMA Elastocol Stick

.2 Description: a primer designed to enhance the adhesion of torch-applied membranes on concrete and other surfaces. Acceptable products:

- .1 Firestone
- .2 IKO Mod-Bit Primer
- .3 SOPREMA Elastocol 500

2.4 Adhesives

.1 Membrane Roofing Materials Adhesive: Cold adhesive-mastic composed of a bituminous binder, added to bonding agents and solvents compatible with specified roofing products.

.2 Low-Rise Foam Adhesive: Manufacturers standard adhesives specifically formulated for installation of plastic insulation to roofing materials:

.1 Acceptable materials:

- .1 Firestone
- .2 IKO Millennium
- .3 Soprema Duotack Adhesive

2.5 Vapour Retarder

.1 Vapour Retarder- A self-adhered vapour barrier membrane composed of SBS modified bitumen membrane with a non-slip surface. Acceptable products:

- .1 Elevate (Firestone)
- .2 Tradesman SBS Glass Base SA (SIPLAST)
- .3 SOPREMA SOPRAVAP'R
- .4 IKO MVP Sand
- .5 Acceptable alternate: IKO Acrylic stick SA (primerless) UV inhibitor

.2 Vapour Barrier Continuity Strip

.1 Description: Waterproofing membrane with composite reinforcement and SBS modified bitumen. The surface is sanded and the underface is self-adhesive and covered with a silicon release film.

2.6 Board Insulation

.1 Board Insulation: Flat and Sloped Insulation: Polyisocyanurate Insulation: to CAN/ULC-S704 and ASTM C1289. Minimum slope = 2%.

- .1 Board Insulation: Flat and Sloped Insulation: Polyisocyanurate Insulation: to CAN/ULC-S704 and ASTM C1289. Minimum slope = 2%.
- .2 Facer: inorganic felt minimum.
- .3 Total thickness of flat stock insulation to provide an insulation value as indicated on Drawings. Install flat stock insulation panels in layers, with minimum thickness of 38 mm at drains.
- .4 All insulation supplied to this project shall have 3rd party certification that it meets the requirements of CAN/ULC-S704 Type 3, Class 3 and ASTM C1289 Type II, Class 1, Grade 3.
- .5 Maximum board size: 1220 mm x 1220 mm.

- .6 Cupped, curled or otherwise damaged boards as deemed by the third party building envelope inspector will not be accepted.
- .7 All insulation shall be stamped with date stamp on date of manufacture and be fully factory cured prior to shipping to distributor and project.
- .8 Cut to minimum slope or such other slopes as noted on the drawings.

2.7 Insulation Overlay Board

- .1 Coverboard: Stonewool Mineral fibreboard panel with rigid surface. Surface of saturated with a coat of bitumen compatible with SBS membranes installed with a torch or hot bitumen, 75 mm thick; 1220 mm x 1220 mm panels.
 - .1 IKO Shieldbase 180
 - .2 Rockwool Toprock DD Plus
 - .3 Soprema Soprarock DD Plus.

2.8 Membrane

- .1 Field Base Sheet
 - .1 Roofing membrane with a nonwoven polyester and glass mat reinforcement and SBS modified bitumen. Top and bottom surfaces are covered with a thermofusible plastic film surface to allow for the installation of a torch applied cap sheet. Acceptable products:
 - .1 IKO TorchFlex-HD-FF-Base
 - .2 SIPLAST Paradiene 20 TG
 - .3 SOPREMA Sopraply base 520
 - .2 Base Stripping
 - .1 Description: Roofing membrane with non-woven polyester or glass mat reinforcement and SBS modified bitumen. The top face is covered with a thermofusible plastic film or talc sand surface to allow for the installation of torch-applied cap sheet. The underside is self-adhesive. Acceptable products:
 - .1 IKO ArmourBond Flash
 - .2 SIPLAST Paradiene 20 TSSA
 - .3 SOPREMA Sopraflash Flam Stick
 - .2 Self-adhered SBS modified bituminous base stripping is to be applied only to new, primed non-treated plywood substrate installed over new perimeter (e.g. at inside face of parapet walls and outside faces of the curbs) or penetration substrates.
 - .3 Field Cap Sheet
 - .1 Description: Roofing membrane with non-woven polyester or glass mat reinforcement and SBS modified bitumen. The top face is covered with protective coloured granules. Colour: grey. Accepted products:
 - .1 IKO TP 250 Cap
 - .2 SIPLAST Parafor
 - .3 SOPREMA Sopralene 250 Cap
 - .4 Cap Stripping
 - .1 Description: Roofing membrane with non-woven polyester or glass mat reinforcement and SBS modified bitumen. The top face is covered with protective coloured granules. Torch-applied cap stripping ply to be same as field cap sheet.
 - .1 IKO PREVENT TP 250 Cap
 - .2 SIPLAST Parafor
 - .3 SOPREMA Sopralene 250 Cap
 - .5 Fire Prevention Tape

- .1 Description: A self-adhesive flame stop membrane composed of glass fleece reinforcement and SBS modified bitumen and is designed to prevent penetration of open flame into voids, holes or gaps in substrate prior to application of a torch-applied membrane.
 - .1 IKO Modiflex tape
 - .2 SIPLAST Fireguard Tape
 - .3 SOPREMA Sopraguard Tape
 - .6 Traffic Sheet: Description: Roofing membrane with non-woven polyester or glass mat reinforcement and SBS modified bitumen. The top face is covered with protective coloured granules, different colour than cap sheet. Torch-applied cap stripping ply 5 mil thickness. Installed at walkway locations.
 - .1 IKO TorchFlex TP-HD- Cap
 - .2 SIPLAST Parafor 30 TG Grey
 - .3 SOPREMA Sopraply Traffic Cap
 - .7 Manufacturers: All membrane components to be warranted by a single manufacturer. Submit complete proposed material list for all roof membrane components to the independent building envelope inspector for review and approval prior to the project start-up meeting.
- 2.9 Adhesives
- .1 Use adhesive to install tapered insulation, flat stock insulation, and insulation overlay board.
 - .1 Description: A low-rise, two-part urethane adhesive. This adhesive can be used to adhere with one or several layers of insulation boards of polystyrene and polyisocyanurate and for gypsum deck levelling and insulation overlay boards. Install in strict accordance with Manufacturer guidelines.
 - .1 IKO Millennium
 - .2 SIPLAST ParaFast
 - .3 SOPREMA Duotack
- 2.10 Liquid Membrane Flashings
- .1 Description: A fluid-applied waterproofing membrane dedicated to cool roof flashing waterproofing without flame in new constructions and/or renovations. It is applied with a brush or roller. All applications must be installed with reinforcement fleece and in accordance with manufacturer installation requirements and written recommendations.
 - .1 IKO MS Detail
 - .2 SIPLAST Parapro 123
 - .3 SOPREMA ALSAN RS 230
- 2.11 Perimeter Attachment
- .1 Perimeter Attachment: Provide termination bar or screws as recommended by manufacturer for complete installation to secure perimeter roofing system to parapet; in accordance with CSA A123.21.
- 2.12 Pavers
- .1 Concrete Pavers: High density hydraulic pressed pavers, nominal 600 mm x 600 mm weight not exceeding 45 kg per unit, colours selected by Consultant from standard range, and as indicated on drawings.
 - .1 Basis-of-Design Materials: Expocrete Pavers

3. EXECUTION

3.1 Quality of Work

- .1 Do examination, preparation and roofing Work in accordance with Roofing Manufacturer's Specification Manual and ARCA Roofing Applications Standards Manual, particularly for fire safety precautions.
- .2 Do priming in accordance with manufacturers written recommendations.
- .3 The interface of the walls and roof assemblies will be fitted with durable rigid material plywood providing connection point for continuity of air barrier.

3.2 Examination of Existing Conditions

- .1 Contractor is to ensure that all materials and equipment on the roof are secured to prevent wind blow-off.
- .2 Contractor is to coordinate with local fire authorities to create a fire safety plan dealing with hot works on the roof. Contractor is to ensure that plan follows guidelines laid out by local authorities.
- .3 Contractor is to follow applicable federal, provincial and local statutes, regulations, and ordinances as required for the transportation of combustible gases.
- .4 Verification of Conditions:
 - .1 Inspect with independent building envelope inspector deck conditions including parapets, construction joints, roof drains, plumbing vents and ventilation outlets to determine readiness to proceed.
- .5 Evaluation and Assessment:
 - .1 Prior to beginning of work ensure:
 - .1 Decks are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris. Do not use calcium or salt for ice or snow removal.
 - .2 Curbs have been built.
 - .3 Roof drains have been installed at proper elevations relative to finished roof surface.
 - .4 Plywood and lumber nailer plates have been installed to deck, walls and parapets as indicated.
- .6 Do not install roofing materials during rain or snowfall.

3.3 Protection of In-Place Conditions

- .1 Cover walls, walks and adjacent work where materials hoisted or used.
- .2 Use warning signs and barriers. Maintain in good order until completion of Work.
- .3 Clean off drips and smears of bituminous material immediately.
- .4 Dispose of rain water off roof and away from face of building until roof drains or hoppers installed and connected.
- .5 Protect roof from traffic and damage. Comply with precautions deemed necessary by the independent building envelope inspector. Remove and replaced damaged roof assembly components at no additional cost to the Owner.
- .6 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed Work and materials out of storage.
- .7 Metal connectors and decking will be treated with rust proofing or galvanization.

- .8 Contractor to ensure that all materials and equipment are prevented from falling or blowing off from the roof during wind events.
- 3.4 Vapour Retarder
- .1 Install primer over entire surface, transitions and roof penetration curbs prior to installation of the vapour retarder.
- .2 Beginning at the bottom of the slope, without permanently installing the vapour retarder membrane, unroll onto the substrate for alignment.
- .3 Ensure the vapour retarder membrane overlaps are supported along their entire length.
- .4 If the vapour retarder membrane is not properly aligned, do not try to adjust it. Instead cut the roll and start again, making sure it is properly aligned and that it overlaps the end of the misaligned piece by 150mm.
- .5 Overlap adjacent vapour retarder membranes by a minimum of 75mm. Overlap end laps by 150mm. Stagger end laps a minimum of 300mm.
- .6 Install self-adhered SBS modified bituminous vapour retarder extensions up the vertical faces of parapet walls and roof penetration curbs to provide a sealed connection to the self-adhered base stripping.
- 3.5 Insulation Installation
- .1 Install taper-cut, insulation over the vapour retarder in stripes/ribbons of low-rise foam adhesive according to the roof plan drawing and in strict accordance with the adhesive Manufacturer's requirements. Install only as much insulation as can be covered in same day.
- .2 Contractor must submit tapered insulation shop drawings to the independent building envelope inspector for review prior to fabrication and installation.
- .3 Install polyisocyanurate insulation panels over the vapour retarder and taper-cut, insulation in stripes/ribbons of low-rise foam adhesive according to the adhesive Manufacturer's requirements for a total overall thickness as detailed on Drawings. Stagger adhered flat stock ISO insulation panels a minimum of 200mm from underlying taper-cut insulation panels and successive layers of polyiso panels. Install only as much insulation as can be covered and sealed in the same day.
- .4 Install insulation for inverted roof systems in accordance with manufacture recommendations.
- 3.6 Installation Of Perimeter Fire Seal (Self Adhered Membrane)
- .1 Apply self adhering perimeter fire seal directly to perimeter and curb substrates prior to application of base sheet materials, to vertical joints in parapet or curb sheathing, and at vertical corners.
- .2 Extend material 75 mm up face of parapet and 75 mm onto substrate, use hand roller to remove air bubbles.
- .3 Install perimeter fire seal to act as temporary moisture seal until installation of flashing materials.
- 3.7 Installation of Insulation Overlay Board / Factory-Laminated Base Sheet
- .1 ADHERE insulation overlay board / factory laminated base sheet in accordance with membrane manufacturer's written instructions. Follow instructions of approval reports for locations of fasteners if required. Avoid the formations of wrinkles, swellings or fishmouths.

3.8 Roof Membrane Installation

.1 Base Stripping/Flashing Installation

- .1 Apply primer to the substrate at a rate of .25 L/m². Primer should be dry before installation of base stripping.
- .2 Before applying membranes, always remove the plastic film on the section to be covered if there is an overlap (inside and outside corners and field surface).
- .3 Position the pre-cut membrane piece. Peel back 100mm to 150 mm of the silicone release paper to hold the membrane in place at the top of the parapet.
- .4 Then, gradually peel back the remaining silicone release paper, pressing down on the membrane with an aluminum applicator to ensure good adhesion. Use the roller applicator to ensure a perfect transition between the up-stand and the field surface. Smooth the entire membrane surface with a roller for full adhesion.
- .5 Cut off corners at end laps to be covered by the next roll.
- .6 Always seal overlaps at the end of the workday.
- .7 Base stripping shall extend a minimum of 100mm onto the field base sheet and upward and over curbs, parapets, etc. or minimum 200mm above the field at walls.
- .8 Fabricate gussets for all inside and outside corners from the base sheet thermofusible membrane. Gussets to be cut from 200mm x 400mm pieces and used to detail corners in conjunction with base stripping. Gussets to be applied on top of the base sheet.

.2 Cap Sheet Installation:

- .1 All modified bitumen membrane systems shall be installed as per Manufacturer's printed requirements and recommendations and:
- .2 Side laps and end laps in adjacent and successive rolls of base and cap sheet and are to be offset at least 300mm and 600 mm respectively. When end lapping onto a cap sheet or base sheet the underlying ply shall be prepared by diagonal trimming of the side of the lap. The granular surface of the cap sheet will require embedding prior to completing an end lap. Exposed cut edges of cap sheet shall be cut with the aid of a straight edge and underlying membrane protected from accidental cutting. Edge laps and end laps are to be 75 mm and 150 mm respectively.
- .3 Install cap sheets starting at the lowest part of the roof and overlap seams such that water runs over the seams or along the seam but not into the seams. Install cap sheet stripping and base sheet stripping such that water runs over or along laps but not into the laps.
- .4 Roll out the cap sheet and allow relaxing as per Manufacturer's recommendations prior to re-rolling and installation.
- .5 Care must be taken not to burn the membranes and their respective reinforcements. 100% of the torch flame is to be directed to the roll of modified bitumen.
- .6 Totally heat weld the two membranes together, free from air pockets, wrinkles, fish mouths or tears. During the torch application of the cap sheet to the base sheet, roll the cap sheet back from time to time to continue to confirm total fusion of the cap sheet to the base sheet (recommended at least once per roll - more often at the beginning of each days 1st roll of cap sheet). The independent building envelope inspector will request cut tests to confirm proper fusion of the cap to the base sheet. The Contractor will repair at no cost to the Owner. Frequency of cut tests will be determined by the independent building envelope inspector.
- .7 Minimize torch smoke staining of cap sheet by angling the torch head away from the adjacent granular cap and blow the smoke out over the uncapped base.
- .8 Install waterproof cut-off to membrane at end of day's operation. Remove water cutoff seal before resuming roofing. Maintain precise fit to new insulation assembly components.
- .9 Bleed-outs on all SBS granular membrane side laps and end laps shall be approximately 6.4mm.

- .3 Cap Sheet Stripping/Flashing Installation
 - .1 The cap stripping must be installed in one-metre-wide strips. The side joints must overlap by 100mm and must be staggered by at least 100mm with respect to the joints of the cap sheet on the field surface to avoid areas of excessive membrane thickness. The overlaps on the field surface must be 50mm. wider than those of the base sheet membrane on the up-stands and parapets. At end laps, angle-cut the corners that will be covered by the following roll.
 - .2 Use a chalk line to draw a straight line on the field surface 150mm. from the up- stands and parapets.
 - .3 The cap stripping sheet must be torch-applied to the base sheet membrane, proceeding from bottom to top.
 - .4 During installation, take care to avoid excessive bitumen bleed-out at joints.
 - .5 Torch-applied cap stripping is to terminate a minimum of 50mm onto the sloped parapet wall cap. The upward facing edge of the cap stripping is to be 'battered out' with a hot trowel onto the surface of the underlying base stripping.
- 3.9 Installation: Liquid Membrane Flashing
 - .1 Install liquid membrane flashing to areas indicated on Drawings in accordance with manufacturer's instructions.
- 3.10 Installation of Heat-Welded Cap Sheets on Upstands and Parapets
 - .1 This cap sheet must be installed in one-metre-wide strips.
 - .2 Overlap side laps along lines provided for this purpose, and overlap end laps by 150 mm (6 in). The side joints must overlap and must be staggered by at least 100 mm (4 in) with respect to the joints of the cap sheet on the field surface, to avoid areas of excessive membrane thickness.
 - .3 Cut off corners at end laps to be covered by the next roll.
 - .4 Use a chalk line to draw a straight line on the field surface 150 mm (6 in) from the upstands and parapets.
 - .5 Use a propane torch and round-nose trowel to embed the surface granules in the layer of hot bitumen starting from the chalk line on the field surface to the bottom edge of the upstand or parapet as well as on the granulated vertical surfaces that are to be overlapped.
 - .6 This cap sheet will be heat-welded directly to the base sheet membrane, proceeding from bottom to top.
 - .7 Avoid the formation of wrinkles, voids or fishmouths.
 - .8 During installation, be careful not to overheat the membrane.
- 3.11 Membrane Walkway Installation
 - .1 Install membrane walkways respecting requirements previously stipulated for cap sheet installation. Apply primer to cap sheet before installing walkways.
- 3.12 Waterproofing for Various Details
 - .1 Install waterproofing membranes in conformance with various roofing details illustrated in the manufacturer's manual instructions and recommendations.
- 3.13 Paver Installation
 - .1 Install in accordance with manufacturer's installation guidelines and as noted on Drawings.

3.14 Field Quality Control

- .1 Inspections: Inspection and testing of roofing application will be carried out by roofing manufacturer to certify required roof warranty.

3.15 Cleaning

- .1 Remove bituminous markings from finished surfaces.
- .2 In areas where finished surfaces are soiled caused by work of this section, consult manufacturer of surfaces for cleaning advice and complying with their documented instructions.
- .3 Repair or replace defaced or disfigured finishes caused by work of this section.
- .4 Remove waste from site daily.
- .5 Ensure that all materials are secured to roof to prevent wind blow-off.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide sheet metal flashing and trim in accordance with requirements of Contract Documents.

1.2 References

.1 Aluminum Association (AA):

- .1 Designation System for Aluminum Finishes
.2 Construction Manual for Specifications for Aluminum Sheet Metal Work In Building Construction

.1 ASTM International (ASTM):

- .3 ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
.4 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
.5 ASTM A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
.6 ASTM B32, Standard Specification for Solder Metal

.2 Canadian Standards Association (CSA):

- .1 CSA A123.3, Asphalt Saturated Organic Roofing Felt

.3 Canadian General Standards Board (CGSB):

- .1 CAN/CGSB 37.5, Cutback Asphalt Plastic Cement (withdrawn)
.2 CAN/CGSB 37.29, Rubber-Asphalt Sealing Compound (withdrawn)

.4 Other References:

- .1 The Alberta Roofing Contractors Association (ARCA): Manual on Good Roofing Practice and Accepted Roofing Systems
.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): Architectural Sheet Metal Manual

1.3 Administrative Requirements

- .1 Coordination: Coordinate work of this Section with interfacing and adjoining Work for proper sequencing of each installation and to provide positive weather resistance, durability of the work, and protection of materials and finishes.
.2 Membrane through wall and roof flashings are identified in affected related sections and specified in Section 07 27 27.

1.4 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
.1 Submit product data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.

- .2 Samples: Submit for Consultant's action. Submit two (2) samples prior to starting work of this section as follows; accepted samples will form the standard of acceptance for the remainder of the work:
 - .1 Submit samples of sheet metal flashing, trim, and accessory items, in the specified finish, as follows:
 - .1 Include 2 or more units showing the full range of variations expected, where finish involves normal colour and texture variations,
 - .2 Include 300 mm square Samples of specified sheet materials indicating exposed finished surfaces.
 - .3 Include 300 mm long samples of factory fabricated products exposed as finished work with specified factory finish.
 - .3 Quality Control Submittals: Submit for Consultant's action. Provide proof of qualifications:
 - .1 Installer: Engage an experienced installer having a minimum of five (5) years' experience who has completed projects similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

2. PRODUCTS

2.1 Metal Flashing Materials

- .1 Zinc Galvanized Sheet Steel Flashing: Tension levelled, Commercial Steel (CS) designation, Type A, Grade 230 in accordance with ASTM A653/A653M and as follows:
 - .1 Thickness: Minimum 0.65 mm (24 ga) base metal thickness unless otherwise noted.
 - .2 Galvanizing Designation: Z275 applied evenly to both sides.
 - .3 Metal Flashing:
 - .1 Surface Texture: Embossed Stucco
 - .2 Finish: Prefinished colour selected from manufacturer's standard range using Baycoat Perspectra Series or Vicwest Weather-X, colour as selected by Consultant.
- .2 Aluminum/Zinc Galvanized Sheet Steel Flashing: Tension levelled, Commercial Steel (CS) designation, Type A, Grade 275 in accordance with ASTM A792/A792M and as follows:
 - .1 Thickness: Minimum 24 ga base metal thickness, and as modified below.
 - .2 Galvanizing Designation: AZM180, applied evenly to both sides.
 - .3 Metal Flashing:
 - .1 Surface Texture: Smooth
 - .2 Finish: Prefinished colour selected from manufacturer's standard range using Baycoat Perspectra Series or Vicwest Weather-X, colour as selected by Consultant.
- .3 Formed Aluminum Flashings: Tension levelled, aluminum sheet in accordance with ASTM B209 and ANSI H35.1 alloy designation 3003-H14 and as follows:
 - .1 Thickness: Minimum 2.00 mm, and as modified by below.
 - .2 Aluminum Flashing: Prefinished colour selected from manufacturer's standard range using Duranar XL.

2.2 Reglets

- .1 Provide secure interlocking of separate reglet and counter flashing pieces compatible with flashing indicated generally of type, material, and profile indicated, formed as follows:
 - .1 Surface Mounted Type: Form with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 - .2 Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.

- .3 Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
 - .4 Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
 - .5 Flexible Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counter flashing or where Drawings show reglet without metal counter flashing.
 - .6 Counter Flashing Wind Restraint Clips: Provide clips being installed before counter flashing to prevent wind uplift of the counter flashing lower edge.
- .2 Material:
- .1 Aluminum: 0.60 mm thick.
 - .2 Galvanized steel: 0.45 mm base metal thickness.
- .3 Acceptable materials: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
- .1 Fry Reglet Corporation.
 - .2 W.P. Hickman Co.
 - .3 Keystone Flashing Company.
- 2.3 Miscellaneous Materials and Accessories
- .1 Solder: ASTM B32, Grade Sn50, used with rosin flux for galvanized steel flashings.
 - .2 Fasteners: Same metal as sheet metal flashing or other non-corrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.
 - .3 Dielectric separator: Bituminous paint: Isolation coating between aluminum and other metallic materials, concrete and preservative treated wood, acid and alkali resistant asphaltic paint in accordance with MPI Architectural Painting Specification Manual Approved Product listing MPI#35
 - .4 Asphalt Mastic: Solvent type asphalt mastic, nominally free of sulphur and containing no asbestos fibres, compounded for 0.40 mm dry film thickness per coat.
 - .5 Mastic Sealant: CAN/CGSB 37.29 polyisobutylene; non-hardening, non-skinning, non-drying, non-migrating sealant.
 - .6 Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Section 07 92 00.
 - .7 Epoxy Seam Sealer: Two component, non-corrosive, aluminum seam cementing compound, recommended by aluminum manufacturer for exterior and interior non-moving joints, including riveted joints.
 - .8 Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather resistant seaming and adhesive application of flashing sheet metal.
 - .9 Slip Sheet: CSA A123.3, No. 15 perforated asphalt saturated felts.
 - .10 Flexible Flashing: Polyethylene faced bituminous membrane materials compatible with membrane air and vapour retarder specified in Section 07 25 13, not less than 0.5 mm thick and be compatible with all other materials being used and mastic compatible and approved for use with the flashing material.
 - .11 Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; non-corrosive; size and thickness required for performance.
 - .12 Roofing Cement: CAN/CGSB 37.5, asbestos free, asphalt based.

- 2.4 Fabrication, General
- .1 Fabricate sheet metal building flashings and trim in accordance with the recommendations of SMACNA's Architectural Sheet Metal Manual that apply to the design, dimensions, metal, and other characteristics as required.
 - .2 Fabricate sheet metal roofing flashings in accordance with the recommendations of the ARCA, and as follows:
 - .1 Make flashing of prefinished metal for cap flashings, for all flashings adjacent to roofing at roof edges and area dividers and where exposed to view from ground.
 - .2 Make flashing for other roof locations, of plain galvanized metal.
 - .3 Fabricate flashings using the following metal core thicknesses for indicated assemblies:
 - .1 Flat Surfaces Less Than 300 mm in Width or Height: Use 0.45 mm material except where specifically noted otherwise.
 - .2 Flat Surfaces 300 mm and Greater in Width or Height: Use 0.62 mm material except where specifically noted otherwise.
 - .3 Concealed Fastening Strips: Use 0.80 mm material.
 - .4 Fabricate sheet metal flashing and trim to fit substrates and result in waterproof and weather resistant performance once installed.
 - .5 Verify shapes and dimensions of surfaces being covered before fabricating sheet metal.
 - .6 Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.
 - .7 Seams: S-lock in accordance with ARCA details. Standing seams in accordance with ARCA details at changes in direction.
 - .8 Aluminum Seams: Fabricate non-moving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - .9 Expansion Provisions:
 - .1 Space movement joints at 3050 mm ^O/c with no joints allowed within 610 mm of corners or intersections
 - .2 Form expansion joints of intermeshing hooked flanges, not less than 25 mm deep, filled with mastic sealant concealed within joints where lapped or bayonet type expansion provisions cannot be used or are not sufficiently weatherproof and waterproof.
 - .10 Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant in accordance with SMACNA standards.
 - .11 Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.
 - .12 Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.
 - .13 Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, non-corrosive metal recommended by sheet metal manufacturer, and as follows:
 - .1 Size as recommended by SMACNA manual or sheet metal manufacturer for application but not less than thickness of metal being secured.

2.5 Sheet Metal Fabrications

- .1 Fabricate sheet metal items in thickness or weight needed in accordance with performance requirements but not less than that listed below for each application and metal.
- .2 Grade Plate: fabricate from coil coated galvanized steel, 24 ga; extend vertically 610 mm below grade as detailed.
- .3 Downspouts: Fabricate from the following material: Coil Coated Galvanized Steel: 0.55 mm thick.
- .4 Splash Pans: Fabricate from the following material: Aluminum: 1.00 mm thick.
- .5 Roof Drain Flashing: Fabricate from the following material: Stainless Steel: 0.40 mm thick.
- .6 Scuppers: Fabricate from the following material: Galvanized Steel: 0.70 mm thick.
- .7 Built-in Gutters: Fabricate from the following material: Terne Coated Stainless Steel: 0.40 mm thick.
- .8 Exposed Trim, Gravel Stops, and Fasciae: Fabricate from the following material: Coil Coated Galvanized Steel: 0.70 mm thick.
- .9 Copings: Fabricate from the following material: Coil Coated Galvanized Steel: 0.0396 inch (1.0 mm) thick.
- .10 Base Flashing: Fabricate from the following material: Coil Coated Galvanized Steel: 0.70 mm thick.
- .11 Counter Flashing: Fabricate from the following material: Coil Coated Galvanized Steel: 0.55 mm thick.
- .12 Flashing Receivers: Fabricate from the following material: Aluminum Zinc Alloy Coated Steel: 0.55 mm thick.
- .13 Drip Edges: Fabricate from the following material: Coil Coated Galvanized Steel: 0.55 mm thick.
- .14 Eave Flashing: Fabricate from the following material: Coil Coated Galvanized Steel: 0.55 mm thick.
- .15 Equipment Support Flashing: Fabricate from the following material: Coil Coated Galvanized Steel: 0.70 mm thick.
- .16 Roof Penetration Flashing: Fabricate from the following material: Galvanized Steel: 0.70 mm thick.
- .17 Overhead Piping Safety Pans: Fabricate from the following material: Stainless Steel: 0.65 mm thick.
- .18 Roof Expansion Joint Cover: Fabricate from the following material: Coil Coated Galvanized Steel: 0.70 mm thick.
- .19 Roof-to-Wall Expansion Joint Cover: Fabricate from the following material: Coil Coated Galvanized Steel: 0.85 mm thick.

2.6 Aluminum Extrusion Fabrications

- .1 Aluminum Extrusion Units: Fabricate extruded aluminum running units with formed or extruded aluminum joint covers for installation behind main members where possible. Fabricate mitred and welded corner units.

3. EXECUTION

3.1 Examination

- .1 Examine substrates and conditions under which sheet metal flashing and trim are being installed and verify that Work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 Installation

- .1 Install sheet metal flashing and trim in accordance with performance requirements, manufacturer's installation instructions, and SMACNA's Architectural Sheet Metal Manual and ARCA.
- .2 Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated.
- .3 Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.
- .4 Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather resistant performance.
- .5 Verify shapes and dimensions of surfaces being covered before fabricating sheet metal.
- .6 Roof Edge Flashings: Secure metal flashings at roof edges at a maximum of 610 mm O/c.
- .7 Expansion Provisions:
 - .1 Provide for thermal expansion of exposed sheet metal Work.
 - .2 Space movement joints at maximum of 3050 mm with no joints allowed within 610 mm of corner or intersection.
 - .3 Form expansion joints of intermeshing hooked flanges, not less than 25 mm deep, filled with mastic sealant (concealed within joints) where lapped or bayonet type expansion provisions in work cannot be used or are not sufficiently weatherproof and waterproof.
- .8 Soldered Joints:
 - .1 Clean surfaces being soldered, removing oils and foreign matter.
 - .2 Pre-tin edges of sheets being soldered to a width of 38 mm, except where pre-tinned surface would show in finished Work.
 - .3 Do not solder the following metals:
 - .1 Aluminum.
 - .2 Coil coated galvanized steel sheet.
 - .4 Pre-tinning is not required for the following metals:
 - .1 Lead.
 - .5 Do not use torches for soldering.
 - .6 Heat surfaces to receive solder and flow solder into joint.
 - .7 Fill joint completely.
 - .8 Completely remove flux and spatter from exposed surfaces.
- .9 Sealed Joints:
 - .1 Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant in accordance with SMACNA standards.
 - .2 Fill joint with sealant and form metal to completely conceal sealant.
 - .3 Use joint adhesive for non-moving joints specified not being soldered.
- .10 Seams:
 - .1 Fabricate non-moving seams in sheet metal with flat lock seams.

- .2 Tin edges being seamed, form seams, and solder.
- .11 Aluminum Seams: Fabricate non-moving seams in aluminum with flat lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
- .12 Separations:
 - .1 Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
 - .2 Underlayment: Install a slip sheet of red rosin paper and a course of polyethylene underlayment where installing stainless steel or aluminum directly on cementitious or wood substrates.
 - .3 Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.
- .13 Install reglets to receive counter flashing in accordance with the following requirements:
 - .1 Provide reglets for installation under Division 03 where reglets are shown in concrete.
 - .2 Provide reglets for installation under Section 04 81 00 where reglets are shown in masonry.
- .14 Counter Flashings:
 - .1 Coordinate installation of counter flashings with installation of assemblies being protected by counter flashing. Install counter flashings in reglets or receivers.
 - .2 Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant.
 - .3 Lap counter flashing joints a minimum of 50 mm and bed with sealant.
- .15 Roof Drainage System:
 - .1 Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the Item manufacturer, to drain roof in the most efficient manner.
 - .2 Coordinate roof drain flashing installation with roof drainage system installation.
 - .3 Coordinate flashing and sheet metal items for steep sloped roofs with roofing installation.
- .16 Overhead Piping Safety Pans: Suspend pans from pipe and install drain line to plumbing waste or drain line.
- .17 Equipment Support Flashing:
 - .1 Coordinate equipment support flashing installation with roofing and equipment installation.
 - .2 Weld or seal flashing to equipment support member.
- .18 Roof Penetration Flashing:
 - .1 Coordinate roof penetration flashing installation with roofing and installation of items penetrating roof.
 - .2 Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
 - .3 Seal and clamp flashing to pipes penetrating roof, other than lead flashing on vent piping.
- .19 Splash Pans:
 - .1 Install where downspouts discharge on low sloped roofs.
 - .2 Set in roof cement or sealant compatible with roofing membrane.

- 3.3 Cleaning and Protection
- .1 Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.
 - .2 Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Performance.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide roof hatches in accordance with requirements of the Contract Documents.

1.2 Submittals

- .1 Submittals: Provide following submittals before starting any work of this Section:
- .1 Product Data: Submit product data for roof hatches including construction, hardware and finishes.
 - .2 Shop Drawings: Submit shop drawings indicating size and description of components, materials, attachment, description of frame and finish, and construction details.

1.3 Project Closeout Submissions

- .1 Provide maintenance data for hardware complete with pertinent details, spare parts lists and warnings against harmful maintenance materials and practices for incorporation into manual specified.

2. PRODUCTS

2.1 Manufacturers

- .1 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
- .1 Bilco Company
 - .2 Lexcor Ltd.
 - .3 Maxam Metal Products Ltd.
 - .4 Nystrom Inc.

2.2 Roof Hatches

- .1 Provide roof hatches with insulated double wall lids and insulated double wall curb frame with integral deck mounting flange and lid frame counter flashing with welded sealed corner joints, continuous weather tight perimeter gasketing and hot dip galvanized hardware, and as follows:
- .1 Size: Single leaf lid, 750 mm x 900 mm.
 - .2 Curb and Lid Material: Galvanized steel sheet, nominal 2.0 mm minimum thickness.
 - .3 Insulation: Polyisocyanurate insulation board, minimum 50 mm thickness or R20.
 - .4 Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid. Thermally broken with EPDM gasket.
 - .5 Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
 - .6 Hardware: Galvanized steel, counterbalanced spring latch with turn handles, butt or pintle type hinge system as standard for manufacturer, and padlock hasps inside and outside.
 - .7 Latching: Single point, using manufacturer's standard latching mechanism having hold open operating arm with vinyl grip handle to permit one handed release.
- .2 Fabricate curbs to maintain a minimum height of 200 mm above top of roofing membrane; provide tapered curb to maintain level lid where slope is greater than 2% - 20 mm in 1000 mm.

2.3 Accessories

- .1 Screws: Manufacturer's standard galvanized steel for mounting curb to structure.
- .2 Gaskets: Resilient gasket to inner face of lid in contact with hatch lid support frame.

- .3 Ladder Safety Post: Manufacturer's standard nominal 40 mm Ø galvanized steel tube ladder safety post; with post locking in place on full extension to 1070 mm above roof surface and release mechanism to return post to closed position, finished with manufacturer's standard baked enamel finish.
- .4 Safety Railing System: Manufacturer's standard safety rail system consisting of nominal 40 mm Ø rails, clamps, fasteners, safety barrier at railing opening, and all accessories required for a complete installation installed so that top of railing is 1070 mm above roof surface, finished with manufacturer's standard baked enamel finish, and as follows:
 - .1 Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members that are exposed to exterior or to moisture from condensation or other sources.
 - .2 Fabricate joints exposed to weather in a watertight manner.
 - .3 Close exposed ends of handrail and railing members with prefabricated end fittings.
 - .4 Basis-Of-Design: Bilco Roof Hatch railing System



2.4 Finishes

- .1 Galvanized Steel Finishes: Baked enamel, colour selected by Consultant from full range.

2.5 Fabrication

- .1 Fabricate components free of twists, bends, or visual distortion and insulated.
- .2 Fabricate flashings to collect and lead off accumulated condensation.

3. EXECUTION

3.1 Installation

- .1 Erect components plumb, level and in proper alignment.
- .2 Verify continuity of building envelope air barrier and vapour retarder systems.
- .3 Adjust and seal assembly with provision for expansion and contraction of components.
- .4 Secure prefabricated curb assembly to structure.
- .5 Coat aluminum in contact with dissimilar materials with isolation coating.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide firestopping in accordance with requirements of the Contract Documents.

1.2 References

- .1 ASTM International (ASTM):
- .1 ASTM A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
 - .2 ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
 - .3 ASTM E814, Standard Test Method for Fire Tests of Penetration Firestop Systems.
 - .4 ASTM E1966, Standard Test Method for Fire-Resistive Joint Systems.
 - .5 ASTM E2307, Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus.
- .2 Underwriters Laboratories of Canada (ULC):
- .1 ULC Guide No. 40 U19, Firestop Systems
 - .2 CAN/ULC S115, Standard Method of Fire Tests of Firestop Systems.
- .3 Underwriters Laboratories (UL):
- .1 UL 1479, Standard for Fire Tests of Through-Penetration Firestops

1.3 System Description

- .1 Firestop Systems: Provide firestop materials and systems designed, tested and installed to resist the spread of fire and the passage of smoke and gases through openings in fire rated assemblies, including floor and wall construction classified in accordance with ANSI/UL 263 (ASTM E119).
- .1 Firestop conditions indicated on the Drawings are relative to design conditions. Contractor's selection of firestop systems shall be suitable for the field conditions, based on the actual size, location and materials used in the Work.
- .2 Test Standards for Firestop Systems: Provide firestop materials which have been tested and rated as systems applicable to each firestop condition in the Work, as listed by ULC "Fire Resistance Directory" or by other qualified testing agency acceptable to the authorities having jurisdiction.
- .1 Firestop system tests are specified by reference to UL standards, and also by reference to equivalent (ASTM) standards for use in comparison with ratings from other acceptable testing agencies. In the event of a difference or discrepancy in ratings or test methods, the provisions of ULC standards shall apply.
- .3 Ratings for Through-Penetration Firestop Systems (FSS): Provide firestop systems tested and classified with ratings to meet the specified requirements.
- .1 Test Procedures for Through-Penetrations: UL 1479 (ASTM E814). Through-penetration systems shall pass test procedures for fire resistance, temperature rise, leakage, and watertightness, as applicable to meet the specified rating requirements.
 - .2 Fire Resistance: The "F Rating" shall equal the fire resistance rating of the surrounding construction, but not less than 1-hour, and shall not exceed the fire resistance rating where the surrounding construction is gypsum board.
 - .3 Temperature Rise: The "T Rating" shall equal the "F Rating", except where a "T Rating" for the firestop condition is exempted by applicable code.
 - .4 Leakage: The "L Rating" shall not exceed 0.005m³/s m² for each penetration or a total of 0.005 m³/s m² for a 9.3 m² area.

- .5 Watertightness: The "W Rating" shall meet or exceed a Class 1 resistance to water pressure for firestop systems in the following locations.
 - .1 Penetrations in exterior wall and roof construction.
 - .2 Floor penetrations in rooms or spaces having a floor drain, and wall penetrations in such areas if any portion of the firestop is 75 mm or less above the floor, such as mechanical / electrical equipment rooms, janitorial rooms or closets, toilet or shower rooms, garage or loading dock areas.
- .6 Insulated Penetrations: Provide firestop systems which shall not require removal of insulation or coverings integral to the penetrants, such as thermal insulation and protective jackets as well as insulation or coverings of electrified components.
- .7 Wall-Opening Protective Materials: Firestop systems are required for protection of wall openings or membrane penetrations such as electrical boxes that pass only through one side of fire-resistance rated walls and partitions. The membrane penetrations and wall-opening protective materials shall meet the firestop conditions set forth by the individual fire test classifications of the wall and partition assemblies.
- .4 Ratings for Firestop Joint Systems (FSS): Provide firestop joint systems tested and classified with ratings to meet the specified requirements.
 - .1 Test Procedures for Joint Systems: ANSI/UL 2079 (ASTM E1966). Firestop joint systems shall pass test procedures for fire resistance, leakage, watertightness, movement capability, and load capacity, as applicable to meet the specified rating requirements.
 - .2 Fire Resistance: Firestop joint "Assembly Rating" shall equal the fire resistance rating of surrounding construction, but not less than 1-hour, and shall not exceed the fire resistance rating where surrounding construction is gypsum board.
 - .3 Leakage: The "L Rating" shall not exceed 0.005 m³/s m² for each penetration or a total of 0.005 m³/s m² for a 9.3 m² area.
 - .4 Watertightness: The "W Rating" shall meet or exceed a Class 1 resistance to water pressure for firestop systems in the following locations.
 - .1 Firestop joints in exterior wall and roof construction.
 - .2 Firestop joints behind floor joint cover assemblies where not equipped with a water drainage system.
 - .3 Floor joints in rooms or spaces having a floor drain, and wall joints in such areas if any portion of the firestop is 75 mm or less above the floor, such as mechanical / electrical equipment rooms, janitorial rooms or closets, toilet or shower rooms, garage or loading dock areas.
 - .5 Movement for Dynamic Joints: The "Movement Capabilities" rating shall be Class I, II, or III, and compatible with the intended movement range for the dynamic joint conditions.
- .5 Ratings for Perimeter Fire-Containment Systems (FSS): ANSI/UL 2079 (ASTM E2307). Provide perimeter fire-containment systems tested and classified with the specified ratings to meet the design requirements.
 - .1 Test Procedures for Perimeter Systems: ANSI/UL 2079 (ASTM E2307). Perimeter fire-containment systems shall pass test procedures for fire resistance, integrity, temperature rise, insulation, leakage, and movement capability, as applicable to meet the specified rating requirements.
 - .2 Fire Resistance: The "F Rating" shall equal the fire resistance rating of the floor assembly.
 - .3 Integrity: The "Integrity Rating" shall equal the "F Rating".
 - .4 Temperature Rise: The "T Rating" shall equal the "F Rating".
 - .5 Insulation: The "Insulation Rating" shall equal the "T Rating".
 - .6 Leakage: The "L Rating" shall not exceed 0.005 m³/s m² for each penetration or a total of 0.005 m³/s m² for a 9.3 m² area.
- .6 Movement for Dynamic Joints: The "Movement Capabilities" rating shall be Class I, II, or III, and compatible with the intended movement range for the dynamic joint conditions.

1.4 Administrative Requirements

- .1 Coordination: Coordinate construction of openings and penetrating items and verify that firestopping and smoke seals systems are installed according to specified requirements and as follows:
 - .1 Coordinate sizing of sleeves, openings, core drilled holes, or cut openings to accommodate firestopping and smoke seals systems.
 - .2 Leave firestopping and smoke seals or joint system installations that will become concealed behind other construction open until Consultant and building inspector, if required by authorities having jurisdiction, have examined each installation.
- .2 Pre-Construction Meeting: Arrange a pre-construction meeting as follows:
 - .1 Meeting shall be attended by Contractor, Subcontractor responsible for firestopping, subcontractors affected by work of this Section.
 - .2 Meeting will discuss requirements for engineered judgements, site conditions, coordination issues and single source responsibility for application of firestop systems; either by the Contractor or by specialty firestop applicator.

1.5 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
 - .1 Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site; include manufacturer's printed instructions for installation.
- .2 Shop Drawings and Schedules: Submit for Consultant's action.
 - .1 Not later than 30 working days following Award of Contract, submit a schedule listing surfaces or components to which firestopping and smoke seals are to be applied, and indicating the manufacturer's firestopping and smoke seal systems, required materials, and detailed installation procedures for review by the Consultant.
 - .2 Determine thickness of applied materials from tests of assemblies identical to the assembly to be protected where possible, conducted in accordance with reference standards listed above.
 - .3 Determine system from available engineering studies, or correspondence with the labelling agency indicating the effect of the differences on the fire separation of the assembly where the assembly to be protected does not correspond exactly to a tested assembly; confirm acceptance of system by local authorities having jurisdiction in writing.
 - .4 Use the same system and material as would be required for a tested assembly with similar conditions where the assembly includes conditions which do not correspond to those included in any previously tested assembly and for which no relevant engineering information is available.

1.6 Quality Assurance

- .1 Regulatory Requirements: Use materials and methods of determining required thickness of application that have the full acceptance of Authority Having Jurisdiction and that are materials tested to ULC S115.
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Ratings: Assemblies containing the materials shall be in accordance with assemblies tested and approved by agencies acceptable to authority having jurisdiction.
 - .2 Materials: Provide materials having fire test response characteristics in accordance with requirements specified in Section 07 05 80.
 - .3 Installers: Apply firestopping and smoke seal materials or systems specified in this Section using fully experienced applicators trained by manufacturer, using proper equipment in strict accordance with manufacturer's instructions.

- .4 Source Responsibility: Obtain through penetration firestop and joint systems, for each kind of penetration and construction condition indicated, from a single source of installation responsibility.

1.7 Delivery, Storage and Handling

- .1 Deliver and store materials in a dry protected area, in original undamaged sealed containers with the manufacturer's labels, application instructions, and labelling agency's labels intact.
- .2 Keep materials dry until ready for use.
- .3 Keep the packages of material off the ground, under cover, and away from sweating walls and other damp surfaces. Discard material that has been exposed to water before actual use.
- .4 Use stock before its expiration date.

1.8 Project Conditions

- .1 Install firestopping and smoke seals materials only when the areas in which they are scheduled are closed-in and protected from dampness.
- .2 Environmental Limitations: Install firestopping and smoke seals systems when ambient or substrate temperatures are within temperature and moisture limits permitted by firestopping and smoke seals system manufacturers or when substrates are not wet due to rain, frost, condensation, or other causes.
- .3 Ventilate firestopping and smoke seals systems in accordance with manufacturer's written instructions by natural means or forced air circulation where natural means are not adequate.

2. PRODUCTS

2.1 Manufacturers

- .1 Subject to compliance with requirements, firestopping and smoke seals systems that may be incorporated into the Work include, but are not limited to, those systems indicated:
 - .1 A/D Fire Protection Systems Inc.
 - .2 Passive Fire Protection Partners Firestop Systems Inc.
 - .3 Hilti Canada Ltd.
 - .4 Johns Manville Fire protection Systems
 - .5 Nuco Self Seal Firestopping Products
 - .6 EZ-Path Fire Rated Pathways
 - .7 Roxtec, Preformed Fire Stopping Systems
 - .8 Specified Technologies Inc.
 - .9 3M Canada Inc.
 - .10 Tremco Ltd.

2.2 Design Requirements

- .1 Delegated Design Requirements: Design firestopping and smoke seals required by the Contract Documents to withstand fire ratings indicated and in accordance with requirements of the Building Code, and as described in Section 07 05 80.
- .2 Performance Requirements: Manufacturer shall design proprietary assemblies to withstand the listed ratings in accordance with the Building Code, Underwriters Laboratories Canada, and authorities having jurisdiction, and as follows:
 - .1 Provide through penetration firestop and joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire resistance rating of assembly penetrated:

- .1 Fire resistance rated load bearing walls, including partitions, with fire protection rated openings.
- .2 Fire resistance rated non-load bearing walls, including partitions, with fire protection rated openings.
- .3 Fire resistance rated floor assemblies.
- .2 F-Rated Systems: Provide through penetration firestop systems with F-ratings indicated, as determined by ULC S115 or ASTM E814, but not less than that equalling or exceeding fire resistance rating of constructions penetrated.
- .3 T-Rated Systems: For the following conditions, provide through penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per by ULC S115 or ASTM E814, where systems protect penetrating items exposed to potential contact with adjacent materials:
 - .1 Penetrations located outside wall cavities.
 - .2 Penetrations located outside fire resistive shaft enclosures.
 - .3 Penetrations located in construction containing fire protection rated openings.
 - .4 Penetrating items larger than 100 mm diameter nominal pipe or 100 cm² in overall cross sectional area.
- .4 Firestopping and Smoke seals Systems Exposed To View: Systems exposed to view, traffic, moisture, and physical damage; provide products that after curing do not deteriorate when exposed to these conditions both during and after construction, and as follows:
 - .1 Provide moisture resistant through penetration firestop systems for piping penetrations for plumbing and wet pipe sprinkler systems.
 - .2 Provide firestopping and smoke seals systems capable of supporting floor loads involved either by installing floor plates or by other means for floor penetrations with annular spaces exceeding 100 mm in width and exposed to possible loading and traffic.
 - .3 Provide firestopping and smoke seals systems not requiring removal of insulation for penetrations involving insulated piping.
 - .4 Provide products with flame spread ratings of less than 25 and smoke developed ratings of less than 50 for firestopping and smoke seals and joint systems exposed to view.
- .5 Fire Resistance of Joint Systems: Assembly ratings and movement capabilities indicated, but with assembly ratings not less than that equalling or exceeding fire resistance rating of constructions in which joints are located.

2.3 Firestopping and Smoke seals

- .1 Compatibility: Provide firestopping and smoke seals systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating firestopping and smoke seals systems, under conditions of service and application, as demonstrated by firestopping and smoke seals system manufacturer based on testing and field experience, and as follows:
 - .1 Service penetration assemblies: certified by ULC in accordance with ULC S115 and listed in ULC Guide No. 40 U19.
 - .2 Service penetration firestopping and smoke seals components: certified by ULC in accordance with ULC S115 and listed in ULC Guide No. 40 U19.13, under the Label Service of ULC.
 - .3 Fire resistance rating of installed firestopping and smoke seals assembly not less than the fire resistance rating of surrounding floor and wall assembly.
 - .4 Firestopping and Smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.
 - .5 Firestopping and Smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal; do not use a cementitious or rigid seal at such locations. Exemption to fire dampers.

- .2 Accessories: Provide components for each firestopping and smoke seals system that are needed to install fill materials and to comply with 1.2 above. Use only components specified by firestopping and smoke seals system manufacturer and approved by the qualified testing and inspecting agency for firestopping and smoke seals systems indicated. Accessories include, but are not limited to, the following items:
- .1 Permanent forming, damming and backing materials, including the following:
 - .1 Slag or rock wool fibre insulation.
 - .2 Sealants used in combination with other forming, damming or backing materials to prevent leakage of fill materials in liquid state.
 - .3 Fire rated form board.
 - .4 Fillers for sealants.
 - .2 Temporary forming materials.
 - .3 Substrate primers.
 - .4 Collars.
 - .5 Steel sleeves.
 - .6 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
 - .7 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
 - .8 Metal fire stop: Commercial galvanized steel, to ASTM A1008/A1008M, zinc coating 260 g/m², minimum metal core thickness 0.912 mm.
 - .9 Steel Deck Moulded Flute Inserts: One piece moulded mineral fibre flute inserts, sized for steel deck profiles, for placement at top of fire rated wall assemblies:
 - .1 Acceptable material: Hilti CP777 Speed Plugs.
 - .10 Labels: Peel-and-stick labels printed with the following information:
 - .1 ATTENTION: FIRE RATED ASSEMBLY. DO NOT MODIFY
 - .2 Name of firestopping manufacturer;
 - .3 Names of products used;
 - .4 Hour Rating of Assembly;
 - .5 Manufacturers standard detail number, or Engineered Judgement identifier; ULC or cUL_{US} Number;
 - .6 Date of installation;
 - .7 Name of installing Subcontractor;
 - .8 Contact telephone number for repair or replacement of firestopping materials.
- 2.4 Fill Materials
- .1 General:
 - .1 Provide firestopping and smoke seals systems containing the types of fill materials indicated in the Firestopping and Smoke seals System Schedule below by reference to the types of materials described in this Article.
 - .2 Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
 - .3 Firestopping products shall have the ability to provide a minimum of STC 55 and have Volatile Organic Compound (VOC) of less than 250 g/L.
 - .4 Firestopping and smoke seal systems shall be tested in accordance with ULC S115, and be comprised of asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke and gases, and not to exceed opening sizes for which they are intended for the ratings as indicated on drawings.
 - .2 Cast-in-Place Firestopping and Smoke seals Devices: Factory assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
 - .3 Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

- .4 Firestopping and Smoke seals Devices: Factory assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrating item.
 - .5 Cable Penetration Devices: Premanufactured intumescent blocks, consisting of a system of inserts and adjustable cores; or premanufactured fire rated cable pathway systems, and as follows:
 - .1 EZ-Path Fire Rated Pathway
 - .2 Roxtec Intumescent Blocks.
 - .6 Intumescent Composite Sheets: Rigid panels consisting of aluminum foil faced elastomeric sheet bonded to galvanized steel sheet.
 - .7 Intumescent Putties: Non-hardening dielectric, water resistant putties containing no solvents, inorganic fibres, or silicone compounds.
 - .8 Intumescent Spray Foam: Expanding spray-in-place intumescent foam sealant.
 - .9 Intumescent Wrap Strips: Single component intumescent elastomeric sheets with aluminum foil on one side.
 - .10 Mortars: Pre-packaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
 - .11 Pillows/Bags: Reusable, heat expanding pillows/bags consisting of glass fibre cloth cases filled with a combination of mineral fibre, water insoluble expansion agents and fire retardant additives.
 - .12 Silicone Foams: Multi-component, silicone based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
 - .13 Silicone Sealants: Moisture curing, single component, silicone based, neutral curing elastomeric sealants of grade indicated below:
 - .1 Grade for Horizontal Surfaces: Pourable (self levelling) formulation for openings in floors and other horizontal surfaces.
 - .2 Grade for Vertical Surfaces: non-sag formulation for openings in vertical and other surfaces.
- 2.5 Mixing
- .1 For those products requiring mixing before application, comply with firestopping and smoke seals system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

3. EXECUTION

3.1 Examination

- .1 Examine surfaces, components, materials to receive firestopping and smoke seals material; report any conditions that would detrimentally affect the application of the material or the proper firestopping and smoke seals of the system.
- .2 Commence Work when conditions of surfaces and the working conditions are suitable.
- .3 Verify service lines are in place, tested and approved where penetration sealants or caulking are required.

- .4 Verify that proper blocking, framing (using non-combustible materials) are properly installed and prepared to receive firestopping and smoke seals. Notify Consultant in writing of any deficiencies affecting the proper performance of the firestopping and smoke seals, do not proceed until deficiencies are corrected.
- .5 Prepare surfaces in contact with firestopping and smoke seals materials and smoke seals to manufacturer's instructions.
- .6 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier where applicable.
- .7 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.2 Preparation

- .1 Provide and maintain masking, drop cloths and polyethylene coverings for such surfaces to protect them during installation operations where adjacent finished floors, walls and similar surfaces are going to be exposed.
- .2 Provide complete enclosures and human protective devices when installing or mixing hazardous materials.
- .3 Surfaces shall be free of oil, grease, dirt, loose paint, mill scale or any other matter that could impair bond, including paint.
- .4 Prime surfaces as required.
- .5 Make provisions for natural ventilation during and subsequent to application of firestopping and smoke seals, sealant or caulking; circulate interior air by use of temporary circulators or exhaust fans in enclosed areas or area lacking openings for natural ventilation.

3.3 Application

- .1 Apply firestopping and smoke seals materials in strict accordance with manufacturer's printed instructions, accepted and approved tested assemblies, and approved details.
- .2 Apply firestopping and smoke seals materials/systems to maintain the fire separations in the project as indicated on drawings.
- .3 Seal holes or voids made by through penetrations, poke through termination devices, and unpenetrated openings or joints and verify continuity and integrity of fire separation are maintained.
- .4 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .5 Tool or trowel exposed surfaces to a neat finish.
- .6 Remove excess compound promptly as work progresses and upon completion.
- .7 Place self-sticking labels on a permanent surface adjacent to firestopping or smoke seal installation.

3.4 Inspection

- .1 Notify Consultant when ready for inspection and prior to concealing or enclosing firestopping and smoke seals materials and service penetration assemblies.
- .2 Cut tests may be made at random by the Owner. Frequency of cut tests shall be determined by the Consultant, but will not be more than 1% of total length of firestopping and smoke seals.
- .3 Make all necessary repairs and correct all deficiencies noted after completion of cut tests.

3.5 Clean-Up

- .1 After completion of firestopping and smoke seals work, remove equipment and clean exposed wall and floor areas to remove excess materials, spatter.

3.6 System Schedule

- .1 Design and provide through penetration firestopping and smoke seals as follows for:
 - .1 Systems with No Penetrating Items: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Intumescent spray foam.
 - .2 Systems for Metallic Pipes, Conduit, or Tubing: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Intumescent spray foam.
 - .3 Systems for Non-metallic Pipe, Conduit, or Tubing: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Intumescent wrap strips.
 - .5 Firestopping and Smoke seals device.
 - .6 Intumescent spray foam.
 - .4 Systems for Electrical, and Data and Communications Cables: Select one or more of the following fill materials:
 - .1 Latex sealant
 - .2 Silicone sealant
 - .3 Intumescent putty
 - .4 Silicone foam
 - .5 Prefabricated Firestop Sleeve (Hilti)
 - .6 Prefabricated Cable Pathways (EZ-Path)
 - .7 Intumescent foam blocks or boards
 - .8 Intumescent spray foam
 - .5 Systems for Cable Trays: Select one or more of the following fill materials:
 - .1 Latex sealant
 - .2 Intumescent putty
 - .3 Silicone foam
 - .4 Pillows/bags
 - .6 Systems for Insulated Pipes: Select one or more of the following fill materials:
 - .1 Latex sealant
 - .2 Intumescent putty
 - .3 Silicone foam
 - .4 Intumescent wrap strips
 - .5 Intumescent spray foam
 - .7 Systems for Miscellaneous Electrical Penetrations: Select one or more of the following fill materials:
 - .1 Latex sealant
 - .2 Intumescent putty
 - .3 Intumescent spray foam

- .8 Systems for Miscellaneous Mechanical Penetrations: Select one or more of the following fill materials:
- .1 Latex sealant
 - .2 Intumescent spray foam
- .9 Systems for Groupings of Penetrations: Select one or more of the following fill materials:
- .1 Latex sealant
 - .2 Intumescent wrap strips
 - .3 Firestopping and Smoke seals device
 - .4 Intumescent composite sheet
 - .5 Intumescent spray foam
- .2 Design and provide joint firestopping and smoke seals as follows for:
- .1 Floor-to-Floor, Fire Resistive Joint System: Provide materials to meet the following criteria:
- .1 Assembly Rating: as indicated.
 - .2 Nominal Joint Width: As indicated
 - .3 Movement Capabilities: To be confirmed, compression or extension.
- .2 Floor-to-Wall, Fire Resistive Joint System: Provide materials to meet the following criteria:
- .1 Assembly Rating: as indicated.
 - .2 Nominal Joint Width: As indicated
 - .3 Movement Capabilities: To be confirmed, compression, extension, or horizontal shear
- .3 Head-of-Wall, Fire Resistive Joint System: Provide materials to meet the following criteria:
- .1 Assembly Rating: as indicated
 - .2 Nominal Joint Width: As indicated
 - .3 Movement Capabilities: Compression and extension
- .4 Wall-to-Wall, Fire Resistive Joint System: Provide materials to meet the following criteria:
- .1 Assembly Rating: as indicated
 - .2 Nominal Joint Width: As indicated
 - .3 Movement Capabilities: Compression and extension
- .5 Design and provide perimeter fire containment firestopping and smoke seals as follows for:
- .1 Perimeter Fire Containment System: Provide materials to meet the following criteria:
- Integrity Rating: as indicated.
 - Insulation Rating: as indicated.
 - Linear Opening Width: As indicated.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide joint sealants in accordance with requirements of the Contract Documents.

1.2 System Description

- .1 Compatibility: Provide only the sealants and joint fillers which are explicitly recommended by the manufacturer for the application, and which have been determined by tests to be totally compatible with the joint surfaces and each other, as stated in the manufacturer's published data or certified by the manufacturer for each application.
- .2 Staining: Provide sealant systems which shall not cause or contribute to staining of substrate surfaces. Manufacturer shall perform staining tests of sealant systems in accordance with ASTM C510, C1248 and ASTM D2203 methods for each joint substrate condition in the Work.
- .3 Adhesion: For elastomeric sealant systems, manufacturer shall test each sealant for bond with each joint substrate condition in the Work. ASTM C719, no failure in adhesion or cohesion. ASTM C794, minimum 66.8 N peel strength with no loss in adhesion.
- .4 Hardness: For sealant systems to be exposed to abrasion and traffic, provide the sealants having suitable hardness to resist damage including indentation by stiletto heel shoes. Determine the proper sealant system and hardness or compressibility in consultation with the manufacturer, considering movement and exposure for the size of each joint.
- .5 Sealant Colour: For fully concealed joints, provide the manufacturer's standard colour which has the best overall performance characteristics for the application. For exposed joints provide the colours as follows.
- .1 Standard Colour: Provide colour selected by the Consultant from manufacturer's standard colours, to match or blend with adjoining materials in a manner to be determined by the Consultant.
- .2 Custom Colour: Provide custom colours where noted, to match the Consultant's sample, or to match or blend adjoining materials in a manner to be determined by the Consultant.

1.3 References

- .1 ASTM International (ASTM):
- .1 ASTM C510, Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
- .2 ASTM C719, Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement (Hockman Cycle).
- .3 ASTM C794, Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
- .4 ASTM C834, Standard Specification for Latex Sealants.
- .5 ASTM C919, Standard Practice for Use of Sealants in Acoustical Applications.
- .6 ASTM C920, Standard Specification for Elastomeric Joint Sealants.
- .7 ASTM C1193, Standard Guide for Use of Joint Sealants.
- .8 ASTM C1248, Standard Test Method for Staining of Porous Substrate by Joint Sealants.
- .9 ASTM C1330, Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
- .10 ASTM D2203, Standard Test Method for Staining from Sealants.
- .11 ASTM D2240, Standard Test Method for Rubber Property-Durometer Hardness.

1.4 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
 - .1 Furnish technical data describing the quality and performance of each material component or system to be used in the Work, e.g., the staining, peel strength, hardness, or other such primary characteristics as required by the Drawings or Specifications.
- .2 Samples: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for colour and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Furnish field samples of each type and colour of joint sealer, not less than 300 mm, installed on site for review by Consultant.
- .3 Certifications: Submit for Consultant's information.
 - .1 Furnish certified test reports verifying that sealants to be used in the Work meet the specified performance requirements.
- .4 Quality Control Submittals: Submit for Consultant's information.
 - .1 Test Reports: Furnish reports of the specified test procedures.

1.5 Quality Assurance

- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- .2 Sealant Manufacturer: Do not use sealant produced by manufacturer who will not agree to send a qualified technical representative to the project site, when requested, for the purpose of rendering advice concerning the proper installation of materials. Begin the installation of each major type of sealant only in the presence of the manufacturer's technical representative.
- .3 Field Samples: Prior to the Pre-Construction Conference, provide a field sample for each type of joint sealer system in the building at areas to be designated by the Consultant. Samples shall represent the primary types of materials, substrate surfaces, joint size, exposure, and other conditions to be encountered in the Work. Utilize the same materials and installation methods in the sample as required for the final Work. Schedule the installation with allowance for sufficient curing time so that the sample may be examined, and any necessary adjustments made, at least 1 week prior to date scheduled for commencing installation of the Work. When accepted, sample areas shall serve as the standard for materials, workmanship, and appearance for such Work throughout the project.
 - .1 Examination of Field Samples: As part of the Pre-Construction Conference, visually examine the samples for staining, dirt pickup, shrinkage, colour, general workmanship and appearance. Cut and pull the sealant from each sample joint, and examine for internal bubbles or voids, adhesion, and general compatibility with substrate.
- .4 Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of National, Provincial and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

1.6 Delivery, Storage, and Handling

- .1 General: Deliver and store materials in manufacturer's original packaging labeled to show name, brand, type, and grade. Store materials in protected dry location off ground in accordance with manufacturer's instructions. Do not open packaging nor remove labels until time for installation.

1.7 Project / Site Conditions

- .1 Weather Conditions: Do not proceed with the Work during inclement weather nor when weather forecasts are unfavorable, unless the Work will proceed in accordance with the manufacturer's requirements and instructions and any agreements or restrictions of the Pre-Construction Conference. Do not proceed under extreme temperature or wind conditions which would cause joint openings to be at either maximum or minimum width during installation and curing of sealants, so that subsequent stresses upon the sealants will be minimized. If installation of sealant is necessary under conditions not listed in the manufacturer's recommendations, consult the sealant manufacturer's representative to establish the proper requirements, then record in writing the conditions under which the installation must proceed and the provisions made to ensure satisfactory Work.

2. PRODUCTS

2.1 Materials

- .1 Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and site experience.
- .2 Colours of exposed joint sealants will be selected by the Consultant from manufacturer's complete range to match adjacent finish materials. Provide paintable sealants for all visible interior locations.
- .3 Elastomeric Joint Sealants: Provide sealants in accordance with ASTM C920 classifications for type, grade, class, and uses related to exposure and joint substrates and as follows:
- .1 Provide products that have been tested in accordance with ASTM C1248 where elastomeric sealants are required for non-staining to porous substrate applications.
- .4 Latex Joint Sealants: Provide sealants in accordance with ASTM C834, temperature Grade to suit related exposure and joint substrates, paintable, non-sag and non-staining for general application.
- .5 Acoustical Sealant for Concealed Joints: Provide sealants in accordance with CAN/CGSB-19.21-M, non-drying, non-hardening, non-skinning, non-staining, gun grade, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission. Coordinate with Section 09 21 16.
- .6 Performance Requirements:
- .1 Provide elastomeric joint sealants for exterior applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- .2 Provide joint sealants for interior applications that establish and maintain airtight and water resistant continuous joint seals without staining or deteriorating joint substrates.

2.2 Liquid Sealants

- .1 Type S-1; acrylic sealant: One part acrylic latex, Shore A Hardness 20, conforming to CAN/CGSB-19.17-M and ASTM C834:
- .1 Use acrylic sealant Type S-1 only on the interior and only in situations where little or no movement can occur.
- .1 Acceptable Materials:
- Spectrem 1
 - GE RCS 20.02 by Momentive
 - Tremco Tremflex 834
- .2 Type S-2; Silicone Sealant: Mould and mildew resistant, Shore A Hardness 15-25, conforming to ASTM C920, Type S, Grade NS, Class 25, use NT, G, and A:

- .1 Use mould and mildew resistant silicone sealant Type S-2 for non-moving joints in washrooms and kitchens; do not use on floors.
 - .1 Acceptable Materials:
 - GE SCS 1700 by Momentive
 - Dow Corning 786
 - Sikasil GP
 - Tremco Tremsil 200
- .3 Type S-3; Silicone Sealant: Exterior Weatherproofing Sealant, One-part, low modulus, neutral cure, Shore A Hardness 15-25, conforming to CAN/CGSB-19.13-M, Classification C-1-40-B-N and C-1-25-B-N, and ASTM C 920, Type S, Grade NS, Class 25, use NT, M, G, A and O, colour as selected by Consultant from Standard Range:
 - .1 Use silicone general construction sealant Type S-3 or polyurethane sealant Type S-7 and S-10 for all joints, interior and exterior, where no other specific sealant type specified; do not use on horizontal traffic joints or where immersed in water.
 - .1 Acceptable Materials:
 - GE SCS 2700 Silpruf LM or GE SWS
 - Dow Corning 791
 - Sikasil N Plus
 - Tremco Spectrum 1/Spectrum 3
- .4 Type S-4, Silicone Sealant: Butt glazing, one part, moisture curing, shore A hardness 15-25, conforming to CAN/CGSB-19.13-M, Classification C-1-40-B-N and C-1-25-B-N and ASTM C920, Type S, Grade NS, Class 25, use NT, G, A, O; Colour: clear (translucent):
 - .1 Use silicone glazing type S-4 for sealing butt glazing joints.
 - .1 Acceptable Materials:
 - GE SCS2000 Silpruf by Momentive
 - Dow Corning 795
 - Chemtron Multiseal
 - Sikasil WS 295
 - Tremco Spectrum 2
- .5 NOT USED: Type S-4; Silicone Sealant: Structural glazing, Shore A Hardness 15-25, conforming to CAN/CGSB-19.13-M, Classification C-1-40-B-N and C-1-25-B-N, and ASTM C 920, Type S, Grade P, Class25, use T, M:
 - .1 Acceptable materials:
 - .1 GE SSG4000 Ultra Glaze by Momentive.
 - .2 Dow-Corning 995.
 - .3 Sikasil N Plus
 - .4 Tremco Spectrem 2.
- .6 Type S-5; interior acoustical sealant: Non-skinning, non-hardening, single component synthetic rubber sealant, conforming to CAN/CGSB-19.21-M:
 - .1 Use acoustical sealant Type S-5 for interior applications only where they will be fully concealed and only where no constant or consistent air pressure difference will exist across the joint.
 - .1 Acceptable Materials:
 - Metaseal
 - Tremco Acoustic Sealant
- .7 Type S-6; air-seal sealant: One part, silicone, shore A hardness 15 – 25, conforming to CGSB 19-GP-13M, classification C-1-40-B-N and C-1-25-B-N and ASTM C920, Type S, Grade NS, Class 25. Use NT, M, G, A and O:

- .1 Use air seal sealant Type S-6 for exterior walls only where constant or consistent air pressure difference will exist across the joint
 - .1 Acceptable Materials:
 - Dow Corning 790
 - GE SCS2700 Silpruf LM by Momentive
 - Sikasil N Plus
 - Tremco Spectrem 1

- .8 Type S-7; two part multi-component sealant: Chemical curing, non-sag, exterior wall sealant, Shore A Hardness 20-35, conforming to CAN/CGSB-19.24-M, Type 2, Class B, and ASTM C920, Type S, Grade NS, Class 25, use NT, M, and A:
 - .1 Use silicone general construction sealant Type S-3 or polyurethane sealant Type S-7 and S-10 for all joints, interior and exterior, where no other specific sealant type specified; do not use on horizontal traffic joints or where immersed in water.
 - .2 Use multi-component sealant Type S-7 for exterior vertical joints where large movement is anticipated; not for continuous water immersion.
 - .3 Use multi-component sealant type S-7 for edge joint sealant at slab edges at walls, columns, interior shaft walls and grade beams.
 - .1 Acceptable Materials:
 - BASF MasterSeal NP2
 - Sikaflex 2c NS E2 Mix
 - Tremco Dymonic FC (single component)

- .9 Type S-8; horizontal joint sealant: Two component, self levelling, conforming to CAN/CGSB-19.24M, Type 1, Class A, and ASTM C920, Type M, Grade P, Class 5, use T, M, and O:
 - .1 Use multi-component sealant Type S-8 for horizontal joint sealant of plaza, floors and decks, exterior areas only, subject to pedestrian and vehicular traffic.
 - .1 Acceptable Materials:
 - Sikaflex 2c SL
 - MasterSeal SL 2

- .10 Type S-10; polyurethane sealant: One component, non-sag, for general construction, Shore A Hardness 15+, conforming to CAN/CGSB-19.13-M, Type 2, Classification MCG-2-25-A-N and ASTM C920, Type S, Grade NS, Class 25, Use NT, M, and A:
 - .1 Use silicone general construction sealant Type S-3 or polyurethane sealant Type S-7 and S-10 for all joints, interior and exterior, where no other specific sealant type specified; do not use on horizontal traffic joints or where immersed in water.
 - .1 Acceptable Materials:
 - BASF MasterSeal NP100
 - Multiflex
 - Sikaflex 1-a
 - Tremco Dymonic FC
 - Tremco Vulkem 116

- .11 Type S-11; saw-cut sealant: Multi-component, self-levelling, conforming to ASTM D2240:
 - .1 Use multi-component sealant type S-11 for saw-cuts in slabs on grade and horizontal joint sealant of plaza, floors and decks, interior areas only.
 - .1 Acceptable Materials:
 - BASF MasterSeal CR100
 - Sika Loadflex 524EZ

- .12 Type S-12; control joint sealant: Two-component, solvent free, flexible urethane, load bearing, conforming to ASTM D2240, Shore A Hardness 65-75:
- .1 Use sealant type S-12 for joint sealant where floor finished "concrete with hardener" and "Ashford Sealer" are specified elsewhere in the Project Manual.
- .1 Acceptable Materials:
- BASF MasterSeal NP2
 - Sika 2C
- .13 Anti-Microbial Concrete Sealant: General purpose, one-component, non-sag, elastomeric, acetoxycure, anti-microbial, silicone sealant/adhesive.
- .1 Basis of Design: Sikasil –GP/-GP HT
- 2.3 Preformed Sealants
- .1 Preformed Silicone Sealant System: Manufacturer's standard system consisting of pre-cured low modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral curing silicone sealant for bonding extrusions to substrates:
- .1 Use two-component flexible epoxy sealant type S-12 for joint sealant where floor finished "concrete with hardener" and "Ashford Sealer" are specified elsewhere in the Project Manual.
- .1 Acceptable Materials:
- Dow Corning Corporation; 123 Silicone Seal.
 - GE UltraSpan US1100 by Momentive.
 - Tremco; Spectrem Ez Seal.
- 2.4 Sealant Backing
- .1 Provide sealant backings of material and type that are non-staining, compatible with joint substrates, sealants, primers, and other joint fillers, and are approved for applications indicated by sealant manufacturer based on site experience and laboratory testing.
- .2 Rod Type Sealant Backings:
- .1 ASTM C1330, Type C (closed cell material with a surface skin), Type O (open cell material) or Type B (bi-cellular material with a surface skin).
- .2 Use any of the preceding types, as approved in writing by joint sealant manufacturer for joint application indicated.
- .3 Size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- .4 Non-adhering to sealant, to maintain two sided adhesion across joint.
- .3 Bond Breaker Tape: Self adhesive polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where three sided adhesion will result in sealant failure.
- 2.5 Accessories
- .1 Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from pre-construction joint sealant substrate tests and site tests.
- .2 Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- .3 Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

3. EXECUTION

3.1 Examination

- .1 Examine joints indicated to receive joint sealants for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance.
- .2 Proceed with installation after unsatisfactory conditions have been corrected.
- .3 Pre-Construction Site Adhesion Testing: Site test adhesive adhesion to joint substrates before installing sealants as follows:
 - .1 Locate test joints where indicated on Drawings or, if not indicated, as directed by Consultant.
 - .2 Conduct site tests for each application indicated below:
 - .1 Each type of elastomeric sealant and joint substrate indicated.
 - .2 Each type of non-elastomeric sealant and joint substrate indicated.
 - .3 Notify Consultant seven (7) days in advance of dates and times when test joints will be installed.
 - .4 Arrange for tests to take place with joint sealant manufacturer's technical representative present in accordance with ASTM C1193, and as follows:
 - .1 Test Method: X1.1 Method A, Site Applied Sealant Joint Hand Pull Tab
 - .5 Verify adhesion to each substrate separately for joints with dissimilar substrates; extend cut along one side, verifying adhesion to opposite side; repeat procedure for opposite side.
 - .6 Report whether sealant in joint connected to pulled out portion failed to adhere to joint substrates or tore cohesively:
 - .1 Include data on pull distance used to test each type of product and joint substrate.
 - .2 Retest until satisfactory adhesion is obtained for sealants that fail adhesively.
 - .7 Evaluation of Pre-construction Site Adhesion Test Results:
 - .1 Sealants not evidencing adhesive failure from testing, in absence of other indications of non-compliance with requirements, will be considered satisfactory.
 - .2 Do not use sealants that fail to adhere to joint substrates during testing.

3.2 Preparation

- .1 Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
 - .1 Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - .2 Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants.
 - .3 Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil free compressed air.
 - .4 Remove laitance and form release agents from concrete.
 - .5 Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
 - .6 Porous joint substrates include the following:
 - .1 Concrete.
 - .2 Masonry.
 - .3 Unglazed surfaces of ceramic tile.
 - .7 Nonporous joint substrates include the following:

- .1 Metal.
 - .2 Glass.
 - .3 Porcelain enamel.
 - .4 Glazed surfaces of ceramic tile.
- .2 Prime joint substrates as recommended in writing by joint sealant manufacturer, based on pre-construction joint sealant substrate tests or prior experience:
- .1 Apply primer to comply with joint sealant manufacturer's written instructions.
 - .2 Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- .3 Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears; remove tape immediately after tooling without disturbing joint seal.
- 3.3 Installation of Joint Sealants
- .1 Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
 - .2 Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
 - .3 Acoustical Sealant Application Standard: Comply with recommendations in ASTM C919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
 - .4 Install sealant backings of type indicated to support sealants during application and at position required to produce cross sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - .1 Do not leave gaps between ends of sealant backings.
 - .2 Do not stretch, twist, puncture, or tear sealant backings.
 - .3 Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
 - .5 Install bond breaker tape behind sealants where sealant backings are not used between sealants and backs of moving joints.
 - .6 Install sealants at the same time backings are installed, and as follows:
 - .1 Place sealants so they directly contact and fully wet joint substrates.
 - .2 Completely fill recesses in each joint configuration.
 - .3 Produce uniform, cross sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
 - .7 Sealants: Immediately after sealant application and before skinning or curing begins, tool non-sag sealants to form smooth, uniform beads, to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint, and as follows:
 - .1 Remove excess sealant from surfaces adjacent to joints.
 - .2 Use tooling agents and profiles that are approved in writing by sealant manufacturer and that do not discolour sealants or adjacent surfaces in accordance with the figures listed in ASTM C1193 as follows:
 - .1 Provide concave joints in accordance with Figure 5A.
 - .2 Provide flush joint in accordance with Figure 5B.
 - .3 Provide recessed joint configuration in accordance with Figure 5C.
 - .4 Use masking tape to protect surfaces adjacent to recessed tooled joints.
 - .8 Install preformed tapes in accordance with manufacturer's written instructions.

- .9 Install preformed silicone sealant system as follows:
- .1 Apply masking tape to each side of joint, outside of area covered by sealant system.
 - .2 Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone sealant system manufacturer's written instructions and covering a bonding area of not less than 10 mm ($\frac{3}{8}$ ").
 - .3 Hold edge of sealant bead 6 mm ($\frac{1}{4}$ ") inside masking tape.
 - .4 Press silicone extrusion into sealant to wet extrusion and substrate within 10 minutes of sealant application.
 - .5 Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 - .6 Complete installation of sealant system in horizontal joints before installing in vertical joints.
 - .7 Lap vertical joints over horizontal joints.
 - .8 Cut silicone extrusion with a razor knife at ends of joints.

3.4 Site Quality Control

- .1 If required, Owner will appoint and pay for the services of a testing agency to conduct site adhesion testing, as follows:
- .1 Extent of Testing: Test completed elastomeric sealant joints as follows:
 - .1 Perform ten (10) tests for the first 300 metres (1000 feet) of joint length for each type of elastomeric sealant and joint substrate.
 - .2 Perform one (1) test for each 300 metres (1000 feet) of joint length thereafter or one (1) test for each floor and elevation.
 - .2 Test Method: Test joint sealants according to Method A, Site Applied Sealant Joint Hand Pull Tab, as appropriate for type of joint sealant application indicated.
 - .3 Verify adhesion to each substrate separately for joints having dissimilar substrates; do this by extending cut along one side, verifying adhesion to opposite side, repeat procedure for opposite side.
 - .4 Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements.
 - .5 Record results in a site adhesion test log, and submit to Owner as a part of Record Document submissions.
 - .6 Inspect tested joints and report on the following:
 - .1 Whether sealants in joints connected to pulled out portion failed to adhere to joint substrates or tore cohesively:
 - Include data on pull distance used to test each type of product and joint substrate.
 - Compare these results to determine if adhesion passes sealant manufacturer's site adhesion hand pull test criteria.
 - .2 Whether sealants filled joint cavities and are free of voids.
 - .3 Whether sealant dimensions and configurations comply with specified requirements.
 - .4 Record test results in a site adhesion test log:
 - Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 - Report any failed tests to the Contractor and the Consultant, and indicate repair procedure undertaken to correct failed sealant.
 - .7 Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints, ensuring that original sealant surfaces are clean and that new sealant contacts original sealant.
- .2 Sealants not evidencing adhesive failure from testing or non-compliance with other indicated requirements will be considered satisfactory:

- .1 Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements.
- .2 Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 Cleaning

- .1 Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 Protection

- .1 Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Performance.
- .2 Cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work if, despite protection measures, damage or deterioration occurs.

3.7 Joint Sealant Schedule

- .1 Where no specified type of sealant is shown or specified choose one of the sealants specified in this Section applicable to that intended application, and consistent with manufacturer's recommendations.
- .2 Seal at all locations where dissimilar material meet, and as follows:
 - .1 Seal perimeters of hollow metal door frames on both sides, and at junction between door frame and resilient or solid flooring materials.
 - .2 Seal perimeters of aluminum door frames on both sides.
 - .3 Seal elevator door frames where they abut concrete or masonry
 - .4 Seal control joints in gypsum board, and junctures between interior partitions with exterior walls.
 - .5 Seal control joints in unit masonry at exterior face.
 - .6 Seal window and door frames around the inside perimeter, so that an airtight seal is obtained, as indicated on drawings.
 - .7 Seal joints at heads of non-load-bearing block walls on both sides, as indicated on drawings.
 - .8 Seal control, expansion joints in floors and walls and around service and fixture penetrations.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide metal door and frames in accordance with requirements of Contract Documents.

1.2 Definitions

- .1 Base Metal Thickness: Thickness dimensions are minimums as defined in referenced ASTM standards for both uncoated steel sheet and the uncoated base metal of metallic coated steel sheets.

1.3 References

- .1 American National Standards Institute (ANSI):
- .1 ANSI/ASME B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
 - .2 ANSI/ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
 - .3 ANSI/ASME B18.6.3, Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series).
 - .4 ANSI/SDI A250.11, Recommended Erection Instructions for Steel Frames.
- .2 ASTM International (ASTM):
- .1 ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
 - .2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .3 ASTM A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
 - .4 ASTM B29, Standard Specification for Refined Lead
 - .5 ASTM B749, Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products
 - .6 ASTM C553, Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - .8 ASTM C592, Standard Specification for Mineral Fibre Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
 - .9 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .10 ASTM E413, Classification for Rating Sound Insulation.
- .3 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB 41-GP-19Ma, Rigid Vinyl Extrusions for Windows and Doors (withdrawn)
 - .2 CAN/CGSB 82.5, Insulated Steel Doors (withdrawn)
- .4 Canadian Steel Door Manufacturers Association (CSDMA):
- .1 Recommended Dimensional Standards for Commercial Steel Doors and Frames.
 - .2 Canadian Fire Labeling Guide for Commercial Steel Door and Frame Products.
- .5 National Fire Protection Association (NFPA):
- .1 NFPA (Fire) 80, Standard for Fire Doors and Other Opening Protectives.

- .6 Underwriters Laboratories Canada (ULC):
 - .1 CAN/ULC S104, Standard Specification for "Tin-Clad" Fire Doors Meeting The Performance Required By S104
 - .2 CAN/ULC S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC S702.1, Standard for Thermal Insulation Mineral Fibre for Buildings.
 - .4 CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Material - Specification.
 - .7 Intertek Testing Services/Warnock Hersey (WHI):
 - .1 Fire Rating Services, Building Materials and Equipment, Listings.
- 1.4 Submittals
- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
 - .1 Furnish technical data describing the quality and performance of each material component or system to be used in the Work, e.g., the fire and acoustical ratings, or other such primary characteristics as required by the Drawings or Specifications.
 - .2 Shop Drawings: Submit shop drawings indicating the following:
 - .1 Elevations of each door design
 - .2 Details of doors including vertical and horizontal edge details
 - .3 Frame details for each frame type including dimensioned profiles
 - .4 Details and locations of reinforcement and preparations for hardware
 - .5 Details of each different wall opening condition
 - .6 Details of anchorages, accessories, joints, and connections
 - .7 Coordination of glazing frames and stops with glass and glazing requirements
 - .8 Reference door types to door schedule; indicate door numbers related to Drawings and Door Schedule.
 - .9 Show details of all conditions.
 - .3 Informational Submittals: Provide the following submittals:
 - .1 Source Quality Control Submittals: Submit information on zinc coating treatment and primer spot treatment, including instructions for surface treatment before site painting and any restrictions or special coating requirements.
 - .2 Certificates: Submit the following certificates or letters of compliance:
 - .1 Oversize Compliance: Submit oversize construction evidence indicating compliance with fire labelling for door and frame assemblies required to be fire protection rated and exceeding size limitations of labelled assemblies.
- 1.5 Quality Assurance
- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
 - .2 Manufacturer: Obtain hollow metal doors and frames from single source of supply and from a single manufacturer, and as follows:
 - .1 Fabricate work of this Section to meet the requirements of the Canadian Steel Door and Frame Manufacturer's Association, Manufacturing Specification for Doors and Frames as a minimum, and as further modified in this section.
 - .2 Fabricator shall be a member in good standing of the Canadian Steel Door and Frame Manufacturer's Association.

- .3 Supplier: Obtain hollow metal doors and frames from single source of supply and from a single manufacturer.
- .4 Installer: Use installers who are experienced with the installation of hollow metal doors and frames of similar complexity and extent to that required for the Project.
- .5 Testing Agencies: Provide doors produced under label service program of a testing agency acceptable to Authorities Having Jurisdiction, and as follows:
 - .1 Steel Fire Rated Doors and Frames: Labelled and listed by an organization accredited by Standards Council of Canada for ratings specified or indicated.
 - .2 Provide fire labelled frame products for those openings requiring fire protection ratings, as scheduled:
 - .1 List by nationally recognized agency having factory inspection service and construct as detailed in Follow-up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
 - .2 Fabricate all rated doors, frames and screens to labelling authority standard.
 - .3 Labeled doors shall be rated for maximum temperature rise in accordance with National Building Code.
 - .4 Affix appropriate label to each opening requiring indicating a labelling requirement listed in Door and Frame Schedule and as follows:
 - .1 At standard size openings: fire endurance rating.
 - .2 At oversized openings: unclassified as to fire rating.

1.6 Delivery, Storage, and Handling

- .1 Deliver doors and frames to project site; provide protection during transit and site storage to prevent distortion or indentation, and any additional protection required to prevent damage to finish of doors and frames.
- .2 Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found:
 - .1 Minor damages may be repaired provided refinished items match new work and are acceptable to the Consultant.
 - .2 Remove and replace damaged items that cannot be repaired as directed by the Consultant, at no additional cost to the Owner.
- .3 Store doors and frames at building site under cover and protected from moisture, blocked off the ground and in a manner to prevent sagging, bowing or twisting using wood blocking and as follows:
 - .1 Remove wet wrapping materials immediately upon delivery.
 - .2 Provide vented shelters to prevent humidity conditions that could damage door and frame finish.
 - .3 Provide space between stacked doors to permit air circulation.

2. PRODUCTS

2.1 Materials

- .1 Steel: Commercial grade steel to ASTM A653, CS, Type B, Coating Designation ZF75 (A25) minimum. Minimum steel thicknesses shall be in accordance with Appendix 1 of the CSDMA, "Recommended Specifications for Commercial Steel Door and Frame Products". (appended to end of this section).
- .2 Primers: Rust inhibitive touch-up only.

- .3 Miscellaneous
 - .1 Exterior Top Caps: Rigid polyvinylchloride extrusion conforming to CGSB 41-GP-19MA.
 - .2 Frame Thermal Breaks: Rigid polyvinylchloride extrusion conforming to CGSB 41-GP-19MA.
 - .3 Sealant: As specified in Section 07 92 00.
 - .4 Glass and Glazing: As specified in Section 08 81 00.
 - .5 Door Silencers (Bumpers or Mutes): Manufacturer's standard grey neoprene silencers; three silencers on strike jambs of single door frames; two silencers on heads of double-door frames; stick on bumpers are not acceptable.
 - .4 Filler: Sound deadening and heat-retarding mineral fiber insulation material. Thermal conductivity not greater than "k" = 0.36 W/m degrees C at 24 degrees C.
 - .5 Fasteners: Galvanized or cadmium plated steel.
 - .1 Bolts and Nuts: ANSI/ASME B18.2.1, B18.2.2, and ASTM A307, Grade A.
 - .2 Machine Screws: ANSI/ASME B18.6.3, and ASTM A307, carbon steel, Phillips flat head.
 - .3 Expansion Bolts: Expansion anchors with galvanized studs and nuts. Acceptable materials:
 - .1 ANKRtite Fastening Systems "Wej-It Anchor Bolt".
 - .2 Hilti Fastening Systems "Kwik-Bolt II"
 - .3 ITW Ramset/Redhead "Trubolt Wedge"
 - .6 Accessories:
 - .1 Glazing Stops:
 - .1 Glass mouldings: Formed steel having 1.00 mm metal core thickness, screw fixed.
 - .2 Accurately fit and butt at corners glazing trim and stops; located on secure side of door, or interior of room window frame.
 - .2 Floor anchors, channel spreaders, nominal 1.60 mm tee anchors, 1.19 mm wall stud anchors, and as follows:
 - .1 Hot dipped zinc coated for exterior locations.
 - .2 Wipe coat galvanized for interior locations.
 - .3 Corrugated, galvanized tee anchors or heavy gauge galvanized wire ties for masonry bond.
 - .4 Drill stud anchors for wire tie to studs.
 - .5 Lag bolts, shields and bushing for existing or concrete openings.
 - .6 Provide anchors appropriate to installation conditions.
- 2.2 Fabrication – Frame Products
- .1 General
 - .1 Exterior frame product: 16 GA– Medium Duty.
 - .2 Exterior frames: welded type construction. Exterior transom frames, sidelight and window assemblies: welded type construction, thermally broken.
 - .3 Interior frame product: 18 GA – Standard Duty.
 - .4 Interior frames and window assemblies: welded type construction. Interior transom frames: welded type construction. Interior sidelight assemblies shall be welded type construction.
 - .2 Frames: mortised, blanked, reinforced, drilled and tapped at factory for templated hardware only, in accordance with approved hardware schedule and templates provided by hardware supplier.
 - .3 Frames in masonry or concrete: Protect mortised cutouts with steel guard .

- .4 Reinforce frame product only, where required, for surface mounted hardware, anchor hinges, thrust pivots, pivot reinforced hinges, or non-templated hardware. Drilling and tapping on site, at time of installation.
- .5 Provide anchorage appropriate to floor, wall and frame construction. Each wall anchor shall be located immediately above or below each hinge reinforcement on the hinge jamb and directly opposite on the strike jamb.
 - .1 For rebate opening heights up to and including 1520 mm (60") provide two (2) anchors, and an additional anchor for each additional 760 mm (30") of height or fraction thereof, except as indicated below.
 - .2 Frames in previously placed concrete, masonry or structural steel: provide with anchors located not more than 150 mm (6") from the top and bottom of each jamb, and intermediate anchors at 660 mm (26") on centre maximum.
- .6 Minimum reinforcing, anchor and other component gauges in accordance with Table 1 of the CSDMA, "Recommended Specifications for Commercial Steel Door and Frame Products".
- .7 Prepare each door opening for single stud rubber door silencers, three (3) for single door openings, two (2) for double door openings, except on gasketed frame product.
- .8 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.
- .9 Accurately miter or mechanically joint frame product.
 - .1 As defined in Appendix 2 of the CSDMA, "Recommended Specifications for Commercial Steel Door and Frame Products", frame product perimeter corner joints shall be:
 - .1 Profile welded; punch-mitered - continuously welded on the profile faces, rabbets, returns and soffit intersections, or saw-mitered - continuously welded on the profile faces, rabbets, returns, stops and soffit intersections. Punch or saw-mitered, at the manufacturer's discretion. All profile welded frame product exposed faces shall be filled and ground to a smooth, uniform, seamless surface.
- .10 Joints at mullions, sills and center rails:
 - .1 cope accurately, butt and tightly fit.
 - .2 At intersecting flush profile faces, securely weld, fill and grind to smooth, uniform, seamless surface.
 - .3 At intersecting recessed profile faces, securely weld to concealed reinforcements, with exposed hairline face seams.
 - .4 At other intersecting profile elements, have exposed hairline face seams.
- .11 Welding: conform to CSA W59.
- .12 Where frame product is install prior to adjacent partition, securely attach floor anchor to inside of each jamb profile. Provide each floor anchor with two (2) holes for securing to floor. For conditions that do not permit the use of a floor anchor, add an additional wall anchor, located within 150 mm (6") of the base of the jamb.
- .13 Weld two (2) temporary jamb spreaders for each door opening to maintain proper alignment during shipment and handling, do not use for installation.
- .14 Form glazing stops from formed steel channel, minimum 16 mm (0.625") height, accurately fit, butt at corners and fasten to frame sections with counter-sunk oval head sheet metal screws.
- .15 Fabricate frame product for large openings in sections as designated on submittal drawings, with splice joints for field assembly and welding.

- .16 Prior to shipment, mark each frame product with an identification number as shown on submittal drawings.

2.3 Steel Frames

- .1 Frame Construction: Provide combination type steel door frames to be used as both door buck and trim, formed to profiles shown. Knocked-down frames will not be accepted.
- .1 Exterior Frames: 1.9 mm galvanized steel.
.2 Interior Frames: 1.5 mm cold-rolled steel. 1.9 mm for frames over 1220 mm wide.
- .2 Mullions and Transom Bars: Closed or tubular construction, as shown. Attach members to heads and jambs of frame with butt-welded joints, unless shown as removable. Reinforce the joints with concealed clip angles of the same thickness as the frame.
- .3 Frame Corners: Provide a full miter continuously welded on back side at corners with edges straight and true. Grind welds smooth and flush on exposed surfaces.
- .4 Jamb Anchors: Tee shaped, corrugated or perforated steel anchors. Adjustable anchors with friction fit for frames set in masonry. Weld anchors to frames set in concrete. Fabricate anchors of same steel material and thickness as used for the frame, 64 mm wide by 250 mm long. Provide 3 anchors per jamb up to 2300 mm jamb height, and 4 per jamb for 2300 mm to 2400 mm height. For frames over 2400 mm, provide 5 anchors plus 1 additional anchor for each additional 600 mm or fraction thereof in height.
- .5 Steel Stud Anchors: Where frames are set into standard drywall or shaft wall steel studs, weld 1.5 mm anchor clips immediately above or below hinge and strike reinforcement and at least 600 mm on center to each jamb and head. Anchor clips shall match the size and type of stud used in each wall.
- .6 Floor Anchors: Support frame by adjustable galvanized steel clip angles, 2.75 mm, welded to frame and punched for two 10 mm fasteners.
- .7 Head Stiffener for Masonry Walls: Reinforce head of frames to be installed in masonry opening over 900 mm wide with 2.6 mm steel channel, unless a structural lintel is provided to support the wall construction above the frame, or unless there is no wall construction above the frame.
- .8 Dust or Mortar Guards: At concealed side of frames, weld full enclosing steel cover boxes over mortises or cutouts for hardware.
- .9 Holes for Rubber Door Silencers: 3 for single doors and 4 for pairs of doors. Install plastic plugs in silencer holes to keep holes clear during installation.
- .10 Door Frame Spreaders: Provide steel channel spreaders at the bottom of door frames to prevent distortion during shipment and storage and to hold frames in proper position until anchorage and adjacent construction has been completed.

2.4 Shop Painting

- .1 Extent: Clean, treat and paint surfaces of the fabricated Work, inside and out, whether exposed or concealed in construction.
- .2 Preparation: Thoroughly clean metal surfaces to remove loose scale, shavings, filings, dirt and other deleterious materials, by use of wire brushes or other effective means. Remove grease and oil by one of the methods specified in SSPC-SP-1 "Solvent Cleaning". Fill as required to fill seams in edges. Chemically treat surfaces to assure adhesion of paint.

- .3 Painting: Apply baked-on enamel primer to obtain uniformly smooth coating on inside and outside surfaces. Provide not less than the minimum coating thickness as recommended by the paint manufacturer.

2.5 Finishing

- .1 Shop apply zinc rich primer to repair damaged zinc coatings arising from fabrication; cure primer fully before shipping to site; include compatible primer for site finishing and correction of surface abrasions to zinc coatings and factory applied primer.
- .2 Remove weld slag and splatter from exposed surfaces.
- .3 Fill and sand smooth tool marks, abrasions and surface blemishes to present smooth uniform surfaces.
- .4 Refer to Section 09 91 00 for site painting doors and frames.

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 Installation

- .1 General: Install the Work at locations shown, in perfect alignment and elevation, plumb, level, straight, true and free from rack. Brace to prevent displacement. Install to the minimum tolerances that are permitted with respect to square, plumb, alignment and twist in accordance with NAAMM recommendations, ANSI A250.11, CSDFMA Installation Guide, manufacturer's data, and as specified in this Section.
- .2 Anchors: Extend frame anchorages below fills and finishes, except over waterproof membrane areas. Anchor bottom of frames to floors with anchor bolts or with power driven fasteners. Coordinate the installation of built-in anchors for wall and partition construction as required with other Work.
- .3 Anchorage to Concrete Walls: Anchor frame jambs to concrete, which has been placed prior to setting of frames, with 10 mm countersunk flathead bolts into expansion type shields or inserts, minimum of 4 per jamb.
 - .1 Soffit Face of Frame: Dimple to accept countersunk bolt head. Reinforce frame with spacer to prevent bowing. Bolt head shall be set slightly below soffit face, filled and ground smooth at time of installation.
- .4 Frame Braces: After wall construction has been completed, remove temporary braces, including spreaders at base of door frames. Leave surfaces smooth and undamaged.
- .5 Finish Hardware: Apply hardware in accordance with hardware manufacturer's instructions and Section 08 71 00 – Door Hardware. Drill and tap for machine screws as required. Do not use self-tapping sheet metal screws. Adjust door installation to provide uniform clearance at head and jambs, and to contact stops uniformly. Remove and replace doors which are found to be warped, bowed or otherwise damaged and cannot be properly fitted in frames. Demonstrate that doors operate freely without binding, and latch properly when closed with moderate force. Coordinate and prep doors are required for Owner's security requirements.

3.3 Adjusting and Cleaning

- .1 Operation: Rehang or replace doors which do not swing or operate freely, as directed by Consultant.
- .2 Upon completion of installation, clean exposed surfaces as recommended by manufacturer and leave ready for final painting.

3.4 Protection

- .1 Protect each unit during construction period so as to leave clean and otherwise free from defects at time of acceptance.
- .2 Site Tests and Inspections

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide wood doors in accordance with requirements of the Contract Documents.

1.2 Definitions

- .1 Factory Manufactured: Doors fabricated by a specialty door manufacturer and shipped through wholesaling or other distribution network.
- .2 Millwork Fabricated: Doors fabricated by an architectural millwork manufacturer and meeting customized requirements for the project.

1.3 References

- .1 Architectural Woodwork Standards referenced in this Section form the basis of the quality standards for materials and installation; materials standards and grading authorities referenced in this Section and listed in the Architectural Woodwork Standard are applicable where specifically referenced and are considered to form a part of and be applicable to this Section.
- .2 American National Standards Institute (ANSI):
- .1 ANSI 208.1, Particleboard.
- .3 Architectural Woodwork Manufacturing Association of Canada (AWMAC):
- .1 AWMAC Architectural Woodwork Standards
- .4 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB 11.3, Hardboard
- .5 The Canadian Hardwood Plywood and Veneer Association (ACCPBD/CHPVA):
- .1 ANSI/ HPVA-1 American National Standard for Hardwood and Decorative Plywood
- .6 Hardwood Plywood and Veneer Association (HPVA):
- .1 Hardwood Plywood Reference Guide and Sales Handbook
- .7 Underwriters Laboratories Canada (ULC):
- .1 ULC S104, Standard Method for Fire Tests of Door Assemblies.
- .8 Window and Door Manufacturers Association (WDMA):
- .1 ANSI/WDMA I.S. 1-A, Interior Architectural Wood Flush Doors

1.4 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
- .1 Furnish technical data describing the quality and performance of each material component or system to be used in the Work, e.g., the fire and acoustical ratings, or other such primary characteristics as required by the Drawings or Specifications.

- .2 Shop Drawings: Submit for Consultant's action. Furnish door schedule and shop drawings for the fabrication and installation of the Work. Show locations, types, sizes, thicknesses, blocking for hardware, cutouts and opening details, finishes, and other pertinent characteristics. Show typical details of conditions for every opening.
- .3 Samples: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for color and appearance only of factory finish. Compliance with all other requirements is the exclusive responsibility of the Contractor.

1.5 Quality Assurance

- .1 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Project Quality Standard: Architectural Woodwork Standard (AWS) published by the Architectural Woodwork Manufacturers Association of Canada, together with authorized additions and amendments will be used as a reference standard and forms part of this project specification, and as follows:
 - .1 Modifications made in this Section that change the requirements of the AWS will govern in case of conflict.
 - .2 References to Economy, Custom or Premium Grade in this specification are as defined in the AWS; any item not given a specific quality grade will be Premium Grade as defined in the AWS.
 - .3 Provide a copy of the AWS for reference purposes on the job site.
 - .4 References in this specification to section, part and item numbers mean those parts and items contained within the AWS.

1.6 Delivery, Storage, and Handling

- .1 General: Deliver doors in protective packaging, marked to clearly identify door type and intended location. Store in a clean, dry, well-ventilated place, protected from dampness, moisture and the weather. Store and handle doors in accordance with AWS recommendations and manufacturer's instructions, and otherwise protect against damage. Allow doors to acclimate to average prevailing humidity in installation area prior to hanging.

1.7 Warranty

- .1 Special Guaranty: Provide manufacturer's standard Lifetime door guaranty with additional riders if necessary, to meet specified guaranty requirements:
 - .1 Guaranty shall contain the provisions of the Standard Wood Door Guaranty of the Architectural Woodwork Manufacturer's Association of Canada stating that doors will not warp or twist to zero tolerance across face of door effective from date of Substantial Performance for the Project.

2. PRODUCTS

2.1 Materials

- .1 Particleboard Door Cores: Industrial particleboard core having minimum density of 450 kg/m³ in accordance with ANSI 208.1, Grade LD-1.
- .2 Fire Rated Door Cores: Non-combustible mineral product complying with requirements of ULC S104 and ULC S113 for fire protection rating indicated; provide composite blocking having improved screw holding capability approved for use in fire rated door construction as required to eliminate through bolting of door hardware.
- .3 Blocking: Hardwood lumber, kiln dried to an average moisture content of between 6% and 12% maximum at time of manufacture, sized and located as required to eliminate through bolting hardware.

- .4 Structural Composite Lumber (SCL): Laminated lumber meeting requirements of WDMA I.S. 10, having screw withdrawal force of nominal 3100 N on face and 1780 N on edge.
- .5 Plastic Laminate Face: Decorative high pressure laminate HGS standard general purpose grade, minimum 1.2 mm thick in accordance with ANSI/NEMA LD3.1. finish as indicted in Section 09 06 06.
- .6 Metal Door Frames: Refer to Section 08 11 00.
- .7 Glass: Clear tempered safety glass as specified under Section 08 81 00.

2.2 Millwork Fabricated Units

- .1 Plastic Laminate Faced Wood Doors: 45 mm thick, Fully bonded core construction, anti-warping door having AWMAC A edge, and as follows:
 - .1 Door Type: Interior, Institutional Type, commercial type Premium Grade in accordance with AWMAC.
 - .2 Duty Rating: Heavy Performance Grade in accordance with WDMA I.S. 1-A.
 - .3 Core Construction: Solid
 - .4 Stiles and Rails: SCL bonded to core and as follows:
 - .1 Side Stiles: SCL with 16 mm hardwood edge; no finger jointed materials permitted.
 - .2 Top and Bottom Rails: SCL with 16 mm soft wood cap.
 - .5 Face Ply: 3 mm, substrate at manufacturers choice, glued to core and stiles, cold pressed Type 1 high solids PVA cross-linked glue.
 - .6 Plastic Laminate: Refer to Section 09 06 06.
 - .7 Glazing Stops: Solid hardwood with mitred corners, painted to match door face.
 - .8 Glass: 6 mm tempered in accordance with Section 08 81 00.
 - .9 Edge Finish:
 - .1 Plastic laminate to match face finish
 - .2 Finish plastic laminate smooth and flush with stile edges of door and bevel at approximately 20 degrees.
 - .3 Apply plastic laminate finish to leading door edge only, leave hinge stile as hardwood; trim door on hinge side only.

2.3 Fabrication

- .1 Fit doors to suit frame opening sizes indicated, having clearance requirements matching referenced quality standard for fitting, with minimum clearances as follows:
 - .1 Between Door and Frame: 1.5 mm on the hinge side; 3 mm on the lock set side and top edge; bevel door edge so that door does not bind in frame.
 - .2 Bottom: 13 mm from top of decorative floor covering; 19 mm maximum from top of non-combustible floor; 10 mm maximum from top of non-combustible sill or threshold.
 - .3 Edge Profile:
 - .1 Single Acting Swing Doors: Bevel 3 mm in 50 mm, ease all edges.
 - .2 Double Acting Doors: Radius vertical edges 60 mm.
- .2 Machine doors to accept recessed hardware; locate hardware in accordance with requirements listed in Section 08 71 00 and templates provided by hardware supplier, and to account for the following:
 - .1 Coordinate with hardware mortises in metal frames to verify dimensions and alignment before machining.

- .3 Openings: Cut and trim openings through doors to account for glazing, with edges reinforced and stops pre-cut to fit; no cut-outs permitted within 125 mm of sides and top of door or 250 mm from bottom of door.

3. EXECUTION

3.1 Examination

- .1 Verify that frames are in accordance with indicated requirements for type, size, location, and swing characteristics and are installed with level heads and plumb jambs.
- .2 Exam all doors thoroughly before installation or finishing; reject any defective doors and obtain replacements from manufacturer at no additional cost to the Owner or Project.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

- .1 Install doors and hardware in accordance with manufacturer's printed instructions; refer to Door Schedule for hardware types and groups; pre-drill pilot holes for hinges, cylindrical locks and similar surface mounted hardware; cut mortises and pre-drill pilot holes for recessed hinges.
- .2 Trim doors as required for proper fit and function; refinish all cut or planed surfaces immediately to match factory finish.
- .3 Do not impair structural strength of door by the application of hardware, cutting and altering the door for lights, louvres or other special details.
- .4 Install mineral core fire doors in accordance with NFPA 80; install metal fire rating label to door, do not cover over with subsequent finishes; do not trim fire rated doors any greater than 3 mm in width from lock side only and 6 mm from bottom of door.

3.3 Closeout Activities

- .1 Deficient Work: Replace, rework or refinish work that does not meet AWS requirements as directed by Consultant.
- .2 Adjusting and Cleaning: Readjust doors and hardware just prior to completion of building to function freely and properly and as follows:
 - .1 Re-hang or replace doors that do not swing or operate freely.
 - .2 Replace doors that are damaged or that do not comply with requirements of this Section; doors may be repaired or refinished where work complies with requirements and shows no evidence of repair or refinishing in completed work.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide access doors and panels in accordance with requirements of the Contract Documents

1.2 References

.1 ASTM International (ASTM):

- .1 ASTM A568/A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
.2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
.3 ASTM A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
.4 ASTM A879/A879M, Standard Specification for Steel Sheet, Zinc-Coated by Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
.5 ASTM A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
.6 ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
.7 ASTM C1396/C1396M, Standard Specification for Gypsum Board

.2 National Fire Protection Agency (NFPA):

- .1 NFPA 80, Standard for Fire Doors and Other Opening Protectives.

.3 Underwriters Laboratories of Canada (ULC):

- .1 ULC S104, Standard Specification for "Tin-Clad" Fire Doors Meeting the Performance Required By S104.

.4 Underwriters' Laboratories (UL), Standards for Safety acceptable to the Standards Council of Canada (SCC).

1.3 Administration Requirements

.1 Preconstruction Meeting: Arrange a pre-construction meeting in accordance with as follows:

- .1 Attendance will be required by the Contractor, major Mechanical and Electrical Subcontractors, and other subcontractors affected by work of this Section; purpose of meeting will be to discuss placement and type of access doors and panels and obtain Consultant's acceptance of locations before completing any permanent work of this Project.

.2 Coordination: Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified in below, and as follows:

- .1 Coordinate locations of all access panels in gypsum board ceilings with Consultant for size and location prior to installation, making every effort to locate outside of gypsum board ceilings. Coordinate with Consultant on-site for access panel locations prior to installation.
.2 Coordinate acceptable locations and sizes with Architectural Reflected Ceiling Plans; no access panels are allowed in public corridors or feature ceilings.
.3 Coordinate closely with mechanical and electrical sections for size and locations of access panels in walls and ceilings; provide access doors and panels required for project.

1.4 Submittals

- .1 Product Data: Submit for Consultants action, product data for each type of door and frame indicated, including construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required) for access doors and frames.
- .2 Shop Drawings: Submit for Consultants action, coordination drawings including plans, elevations, sections, details and attachments to other work. Detail fabrication and installation of access doors and frames for each type of substrate.
- .3 Samples: Submit for Consultants action, samples for each door face material 75 mm x 125 mm in size, in each finish selected for project.
- .4 Product Schedule: Submit for Consultants action, complete door and frame schedule, including types, general locations, sizes, construction details, latching or locking provisions, and other data pertinent to installation.

1.5 Quality Assurance

- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work
- .2 Regulatory Requirements: Provide fire rated access doors and frames in accordance with NFPA 80 or ULC S104, and labelled and listed by UL, ULC or ITS/Warnock Hersey, or another testing and inspecting agency acceptable to Authority Having Jurisdiction and Section 07 05 80.

1.6 Delivery, Storage and Handling

- .1 General: Deliver and store materials in manufacturer's original packaging labeled to show name, brand, type, and grade. Store materials in protected dry location off ground in accordance with manufacturer's instructions. Do not open packaging nor remove labels until time for installation.

1.7 Warranty

- .1 Special Warranty: Submit for Owner's documentation. Furnish 2 year written warranty in form stipulated by Consultant, signed by the Contractor and Installer, agreeing to repair or replace Work which has failed as a result of defects in materials or workmanship. Upon notification of such defects, within the warranty period, make necessary repairs or replacement at the convenience of the Owner. Other guarantees or warranties may not be substituted by the Contractor for the terms of this special warranty.

2. PRODUCTS

2.1 Non-Rated Architectural Access Panels

- .1 Flush doors and trimless frames, fabricated as follows:
 - .1 Aluminum Extrusions: ASTM B221, alloy 6063-T6.
 - .2 Door: Extruded aluminum frame with gypsum board inlay and structural nylon corner elements:
 - .1 Gypsum Board: to ASTM C1396/C1396M, 13 mm and 16 mm thickness to match adjacent construction.
 - .2 Size: Square sized to suit access requirements if not indicated on Drawings.
 - .3 Latch: Flush cam latch operated by tamper-resistant torx drive.
 - .4 Hinge: Concealed, two point pin hinge, non-corroding, allowing door to open 120° and allowing door to be removed.
 - .5 Edge Bead: Recessed extruded aluminum frame edge bead providing surface that can be finished to adjacent gypsum board.

- .6 Accessories: Fibreglass reinforced nylon, zinc plated screws, stainless steel springs and retaining wire to manufacturer's standard.
- .7 Finish: Aluminum frames, gypsum board, nylon and aluminum cam latch to receive the same finish and paint as the surrounding surface.
- .8 Acceptable materials:
 - .1 Access Panel Solutions, BaucoPlus II Architectural Access Panel

2.2 Fire Rated Access Panels in Gypsum Board

- .1 Flush, fire rated access doors and trimless frames, fabricated from zinc coated steel sheet, and as follows:
 - .1 Cold-Rolled Steel Sheets: ASTM A1008/A1008M, Commercial Steel (CS), or ASTM A1008/A1008M, Drawing Steel (DS), Type B; stretcher-levelled standard of flatness; with minimum thickness indicated representing specified nominal thickness according to ASTM A568/A568M.
 - .2 Galvanizing: Electrolytic zinc-coated steel sheet, complying with ASTM A879/A879M, Class C coating or ASTM A653/A653M Z180 (G60) mill phosphatized zinc coating, at fabricator's option.
 - .3 Door: Flush panel, minimum thickness of 0.95 mm.
 - .4 Latch: Self-latching bolt operated by standard screwdriver with interior release.
 - .5 Hinge: Concealed, two point pin hinge, non-corroding, allowing door to open 120° and allowing door to be removed.
 - .6 Automatic Closer: Spring type.
- .2 Edge Beads: Edge trim formed from 0.80 mm nominal thickness zinc coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.
- .3 Door Frame: Minimum 1.6 mm thick sheet metal with gypsum board bead.
 - .1 Acceptable materials: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 Acudor Products, Inc., FB-5060-DW
 - .2 Nystrom Building Products Co., UW Series

2.3 Fabrication

- .1 Provide access door assemblies manufactured as integral units ready for installation.
- .2 Provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness for metal surfaces exposed to view in the completed Work.
- .3 Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
- .4 Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed based on size of door or panel opening.
- .5 Apply manufacturer's standard protective coating on aluminum that will come in contact with concrete after fabrication.

2.4 Finishes

- .1 Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- .2 Finish metal fabrications after assembly.
- .3 Aluminum Finishes:
 - .1 Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - .2 As-Fabricated Finish: AA-M10 Mechanical Finish: as fabricated, unspecified (mill finish).
- .4 Steel Finishes:
 - .1 Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. For galvanized surfaces, apply, after cleaning, a conversion coating suited to the organic coating to be applied over it. For zinc coated surfaces, clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A780/A780M.
 - .2 Factory Priming for Field-Painted Finish: Apply shop primer immediately after cleaning and pre-treating, as follows:
 - .1 Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate free, universal modified alkyd primer selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
 - .2 Shop Primer for Zinc Coated Steel: Organic zinc-rich primer complying with SSPC-Paint 20 and compatible with topcoat.
 - .3 Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

3. EXECUTION

3.1 Preparation

- .1 Advise installers of other work about specific requirements relating to access door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

3.2 Installation

- .1 Provide access doors to locations indicated on drawings and for the following:
 - .1 Valves
 - .2 Volume and splitter dampers
 - .3 Fire dampers
 - .4 Cleanouts and traps
 - .5 Fan coil/force flow units
- .2 Install access doors in walls and ceilings in accordance with reviewed shop drawings and manufacturer's printed instructions.
- .3 Co-ordinate exact location of access doors with other trades.
- .4 Ensure correct types of access doors and installed to accommodate applied wall and ceiling finishes.

3.3 Adjusting and Cleaning

- .1 Adjust doors and hardware after installation for proper operation.
- .2 Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide Side Folding security grille in accordance with requirements of the Contract Documents.

1.2 References

- .1 American Architectural Manufacturers Association (AAMA):
 - .1 AAMA 609.1, Voluntary Guide Specification for Cleaning and Maintenance of Architectural Anodized Aluminum.
 - .2 AAMA 611, Voluntary Specification for Anodized Architectural Aluminum.

1.3 Submittals

- .1 Product Data: Submit for Consultant's action manufacturer's printed product literature, specifications and data sheets for each size of side folding grille and accessory.
- .2 Shop Drawings: Submit for Consultant's action shop drawings for special components and installations not dimensioned or detailed in manufacturer's standard product literature; indicate assembly and instruction details, dimensions of fabrication, required clearances materials, finishes, and hardware. Indicate location of drop pins in countertop.
- .3 Maintenance Data: Submit for Consultant's action operation and maintenance data for side folding grilles and closures and hardware for incorporation into manual specified.
- .4 Samples for Verification: Submit for Consultant's action two (2) samples of each type of exposed finish required, prepared on samples of size indicated below for final verification:
 - .1 Door Curtain: 300 mm long
 - .2 End Post: 150 mm long.
 - .3 Intermediate Post: 150 mm long.
 - .4 Lead Post: 150 mm long.
 - .5 Floor Guide: 150 mm long.
 - .6 Panel Inserts: 300 mm long.

1.4 Project Closeout Submissions

- .1 Provide operation and maintenance data for side folding grilles and closures and hardware for incorporation into manual.

1.5 Quality Assurance

- .1 Regulatory Agencies: Provide electrical components, devices and accessories, motors, controls and wiring conforming to CSA Standards and CSA labelled in accordance with requirements of Authority Having Jurisdiction.
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Manufacturer: Obtain products listed in this Section from listed manufacturers and that have local distribution for the past two (2) years.
 - .2 Installers: Use installers that have completed manufacturer's authorized training program and that certified to install and maintain units delivered for this Project.

2. PRODUCTS

2.1 Manufacturers

- .1 Basis-of-Design products are named in this Section; additional manufacturers offering similar setting systems may be incorporated into the work provided they meet the performance requirements established by the named products.

.2 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

- .1 Cookson Company
- .2 Cornell Ironworks
- .3 Dynamic Closures Corporation
- .4 Dynafair Corp. Canada Inc.
- .5 Kinnear/Wayne-Dalton Corporation
- .6 Mobileflex
- .7 Overhead Door Corporation

2.2 Side Folding Grilles

.1 Door Curtain: 178 mm wide perforated aluminum panels in aluminum frame:

- .1 Max Height 4267 mm
- .2 Panel Width 178 mm
- .3 Min. Pocket Width 203 mm
- .4 Weight Stacked 71kg/m²
- .5 Weight Extended 15kg/m²
- .6 Hinge Type 1 Piece Continuous
- .7 Stack Ratio 6% of curtain width
- .8 Stack Formula (Estimated): 6% of curtain width plus 76 per post
- .9 Finish: Black Anodized Aluminum.

.2 Posts: as required for each installation, confirm with Consultant:

Post Data



	Post 1	Post 2	Post 3	Post 3	Post 5	Post 7	Post 9	Post 10
Dimension	Wall Channel	Hookbolt Lead	Bi-Part Channel	Bi-Part Hookbolt	Intermediate	Top and Bottom	Trailing	Fixed
Width to Door Length	0.75" [19]	2.75" [70]	1" [25]	2.75" [70]	2.75" [70]	3" [76]	1.5" [38]	0.75" [19]
Width to Stack Depth	0.75" [19]	2.75" [70]	1" [25]	2.75" [70]	2.75" [70]	3" [76]	1.5" [38]	0.75" [19]
Min Height	2" [51]	21.25" [540]	21.25" [540]	21.25" [540]	21.625" [549]	32.125" [816]	21.25" [540]	21.25" [540]
Max Height	168" [4267]	168" [4267]	168" [4267]	168" [4267]	168" [4267]	168" [4267]	168" [4267]	168" [4267]
Top Lock Rod Travel	-	-	-	-	-	-	-	-
Bottom Lock Rod Min Travel	-	-	-	0.5" [13]	0.5" [13]	0.5" [13]	-	-
Bottom Lock Rod Max Travel Floor	-	-	-	3.5" [89]	3.5" [89]	3.5" [89]	-	-
Bottom Lock Rod Max Travel Counter	-	-	-	2.5" [64]	2.5" [64]	2.5" [64]	-	-
Lock Height Floor Application	-	47" [1194]	47" [1194]	47" [1194]	47" [1194]	47" [1194]	-	-
Lock Height Counter Application	-	17" [432]	17" [432]	17" [432]	17" [432]	17" [432]	-	-
Features								
Adjustable Top Hanger	-	•	•	•	•	•	•	•
Universal LH and RH	•	•	•	•	•	•	•	•
Flush Mounted Lock Rod Operation	-	-	-	•	•	•	-	-
Pull Strap	-	Std over 108" [2743]	Std over 108" [2743]	-	-	Std over 108" [2743]	-	-
Plastic Flange 7" [178] [Max 120" [3048]]	-	-	-	-	-	•	Std With EL	-
Plastic Flange 4.5" [114] [Max 120" [3048]]	-	-	-	-	-	•	Std With SL	-

.3 Hardware: Manufacturers standard hardware and as follows:

- .1 Top Track: Extruded aluminum Nominal 32 mm x 40 mm, with manufacturers standard radius curves. Tempered aluminum alloy 6351-T6.
- .2 Hangers: Ball bearing type.
- .3 Locking Post: Single, side opening locking post configuration.
- .4 Locking: Provide cylinder locks operable from both sides for leading post locking, provide one cylinder lock and spring loaded dustproof drop bolt to intermediate members. Confirm with Consultant for locking options:

Locking Options



.4 Egress Door: where indicated on Drawings, provide egress opening as follows:

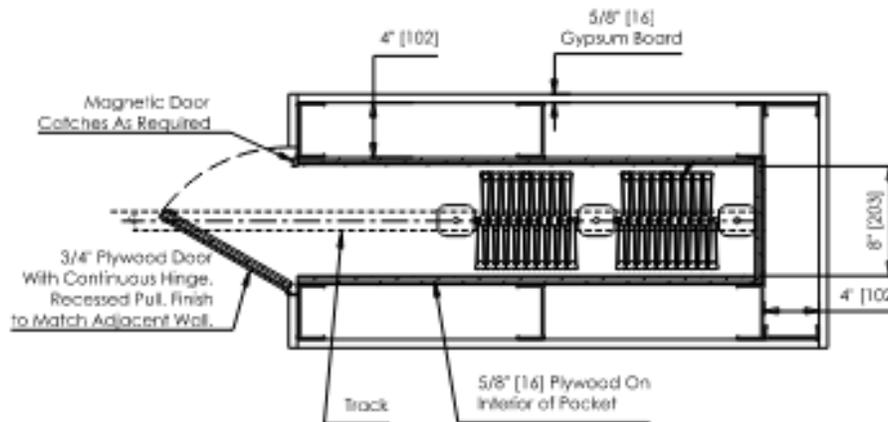
- .1 Clear Opening Width (Egress Door) 36" [914]
- .2 Clear Opening Height (Egress Door) 80.75" [2051]
- .3 Min Door Opening Height Required 89.375" [2270]
- .4 Hand of Operation LH/RH
- .5 Total Length (includes Bi-Part Post) 36" [914]
- .6 Stack Required (includes Bi-Part Post) 6" [162]

.5 Basis-of-Design Material: Dynamic Closures, EL Series, EL Paravent.

2.3 Stacking Pocket

- .1 Provide stacking pocket for grille in closed position. Include locking hinged doors on pocket.
- .2 Confirm with Drawings for custom curves required.

EL Straight Pocket (Typical)



2.4 Aluminum Finishes

- .1 Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- .2 Black Anodized Finish:
 - .1 Class I Finish: Architectural Class I, clear coating 0.018 mm or thicker in accordance with AAMA 611.

2.5 Operation

- .1 Equip grille for operation by: Hand, install handles.

3. EXECUTION

3.1 Installation

- .1 Install side folding grilles, operating equipment and required hardware, jamb and head moulding strips, anchors, inserts, hangers, and equipment supports in accordance with shop drawings, manufacturer's written instructions and as specified.
- .2 Install master keyed cylinder coordinate with Section 08 71 00.
- .3 Adjust operating components to ensure smooth opening and closing of side folding grilles and closures.

3.2 Cleaning

- .1 Perform cleaning of aluminum components in accordance with: AAMA 609.1 - Voluntary Guide Specification for Cleaning and Maintenance of Architectural Anodized Aluminum.
- .2 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .3 Clean aluminum and stainless steel with damp rag and approved non-abrasive cleaner in accordance with manufacturer's instructions.
- .4 Remove traces of primer, caulking materials; clean grilles and frames.
- .5 Clean glass and glazing materials with approved non-abrasive cleaner.
- .6 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide Aluminum Framed Entrances and Storefronts in accordance with requirements of the Contract Documents

1.2 Definitions

- .1 Equal Dimensions: Entrance system assemblies indicating equal dimensions on the Drawings shall be calculated to align with in-place structural elements followed by even division of the space between structural elements. This shall mean that entrance system materials are evenly spaced between adjacent structural members, not necessarily evenly spaced across the entire wall assembly.

1.3 References

- .1 Harmonized North American Fenestration Standard, AAMA/WDMA/CSA 101/I.S.2/A440 – “NAFS North American Fenestration Standard / Specification for Windows, Doors and Skylights.
- .2 American Architectural Manufacturers Association (AAMA)/Window and Door Manufacturers Association (WDMA):
 - .1 ANSI/AAMA/NWDA 101/I.S.4, North American Fenestration Standard/Specification for Windows, Doors and Skylights.
 - .2 AAMA 910, Voluntary "Life Cycle" Specifications and Test Methods for AW Class Architectural Windows and Doors.
 - .3 CSA A440.2 – Fenestration Energy Performance; used to establish temperature index (I) value.
- .2 Aluminum Association (AA):
 - .1 Aluminum Design Manual.
- .3 American Architectural Manufacturer's Association (AAMA):
 - .1 AAMA 611, Voluntary Specification for Anodized Architectural Aluminum.
 - .2 AAMA 701, Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals
 - .3 SFM-1, Aluminum Storefront and Entrance Manual.
- .4 American National Standards Institute (ANSI):
 - .1 ANSI H35.1/H35.1M, American National Standard Alloy and Temper Designation Systems for Aluminum.
 - .2 BHMA A156.1, Butts and Hinges.
 - .3 BHMA A156.3, American National Standard for Exit Devices.
 - .4 BHMA A156.4, Door Controls - Closers.
 - .5 BHMA A156.5, Cylinders and Input Devices for Locks.
 - .6 BHMA A156.6, Architectural Door Trim.
 - .7 BHMA A156.8, Door Controls - Overhead Stops and Holders.
 - .8 BHMA A156.16, Auxiliary Hardware.
 - .9 BHMA A156.21, American National Standard for Thresholds.
- .5 ASTM International (ASTM):
 - .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .3 ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .4 ASTM B308/A308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

- .5 ASTM B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - .6 ASTM E330/E330M, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - .7 ASTM E331, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
 - .6 CSA Group (CSA):
 - .1 CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CSA W47.1, Certification of companies for fusion welding of steel.
 - .3 CSA W47.2, Certification of companies for fusion welding of aluminum.
 - .4 CSA W59, Welded Steel Construction (Metal Arc Welding).
 - .5 CSA W59.2, Welded Aluminum Construction.
 - .7 Canadian Welding Bureau (CWB Group Industry Services):
 - .1 CWB 112E, Welding Symbols Study Guide.
 - .2 CWB 113E, Weld Quality and Examination Methods Study Guide.
 - .8 The Society for Protective Coatings (SSPC)/National Association of Corrosion Engineers (NACE International):
 - .1 Surface Preparation Guidelines:
 - .1 SSPC-SP COM, Surface Preparation Commentary for Metal Substrates.
 - .2 SSPC-PS Guide 12.00, Guide to Zinc-Rich Coating Systems.
- 1.4 Administrative Requirements
- .1 Preconstruction Meeting: Arrange a pre-construction meeting in accordance with as follows:
 - .1 Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - .2 Review location and alignment of vertical and horizontal elements as they relate to the aesthetic criteria indicated on the Drawings, and the technical requirements indicated on the shop drawings.
- 1.5 Submittals
- .1 Product Data: Submit for Consultant's action as follows:
 - .1 Submit product data including construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.
 - .2 Shop Drawings: Submit for Consultant's action as follows:
 - .1 Submit shop drawings detailing fabrication and assembly for aluminum framed entrance and storefront systems including plans, elevations, sections, details, and attachments to other work and the following:
 - .1 Details of provisions for system expansion and contraction and for draining moisture occurring within the system to the exterior.
 - .2 Hardware schedule and operating hardware types, functions, quantities, and locations.
 - .3 Connections to adjacent air and vapour membranes.
 - .4 Isometric drawing indicating joinery, anchorage, flashing and drainage provisions.
 - .3 Samples: Submit for Consultants action samples of each type of exposed finish required in manufacturer's standard sizes for verification of colours selected for the Project.

- .4 Source Quality Control Submittals: Submit pre-construction sealant test reports for structural sealant glazed systems, compatibility and adhesion test reports from sealant manufacturer indicating that materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with sealants, including sealant manufacturer's interpretation of test results for sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion.
- 1.6 Project Closeout Submissions
 - .1 Provide operations and maintenance information.
 - .2 Submit data for cleaning of aluminum finishes and maintenance of operational hardware.
- 1.7 Quality Assurance
 - .1 Qualifications: Provide proof of qualifications when requested by the Consultant:
 - .1 Installer: Use personnel experienced with the materials specified, with work of similar complexity to that indicated for the project, and who are acceptable to manufacturer.
- 1.8 Site Conditions
 - .1 Site Measurements: Verify actual locations of structural supports for aluminum framed entrance and storefront systems by site measurements before fabrication and indicate measurements on Shop Drawings.
 - .2 Established Dimensions: Establish dimensions and proceed with fabricating aluminum framed entrance and storefront systems where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions.
- 1.9 Warranty
 - .1 Manufacturer Warranty: Provide warranty, signed and issued in the name of Owner, to replace the following items for defective material and workmanship for the time stated from date of Substantial Performance:
 - .1 Framing, panels and glazing: Failure of performance requirements; 2 years.
 - .2 Sealed glass units: misting, dusting and seal failure; as indicated in Section 08 81 00 – Glass and Glazing.
 - .3 Joint sealants, caulking: Failure to maintain seal; 2 years.
 - .4 Aluminum brake shapes: oil-canning and delaminations; 2 years.
 - .5 Finishes: Failure specified finishes not attributable to normal weathering; 20 years.
- 2. PRODUCTS**
 - 2.1 Manufacturers
 - .1 Basis-of-Design products are named in this Section; additional manufacturers offering similar aluminum framed entrance and storefront systems may be incorporated into the work provided they meet the performance requirements established by the named products.
 - .2 Acceptable Materials Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 Alumicor Limited
 - .2 Ferguson Glass Western Ltd. (Engineered Aluminum Products Inc. (EAP))
 - .3 Fulton Industries Inc.
 - .4 Kawneer Canada Ltd.
 - .5 US Aluminum/CRL
 - .6 Oldcastle Building Envelope

- .3 Substitution Limitations: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of the aluminum framed entrance and storefront systems required for the Project as follows:
 - .1 Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - .2 Performance characteristics are indicated by criteria subject to verification by one or more methods including pre-construction testing, site testing, and in-service performance.

2.2 Design Criteria

- .1 Provide aluminum framed entrance and storefront systems, including anchorage, capable of withstanding, without failure, the effects of the following:
 - .1 Structural loads.
 - .2 Thermal movements.
 - .3 Movements of supporting structure including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 - .4 Dimensional tolerances of building frame and other adjacent construction.
- .2 Failure of performance requirements will be considered to include, but not be limited to, the following:
 - .1 Deflection exceeding specified limits.
 - .2 Thermal stresses transferred to building structure.
 - .3 Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - .4 Noise or vibration created by wind and thermal and structural movements.
 - .5 Loosening or weakening of fasteners, attachments, and other components.
 - .6 Sealant failure.
 - .7 Failure of operating units to function properly.

2.3 Materials

- .1 Aluminum: Materials recommended by manufacturer for type of use and finish indicated, and as follows:
 - .1 Sheet and Plate: In accordance with ASTM B209/B209M, and ANSI H35.1 AA1100-H14, or AA5005-H32 or H34, anodizing quality.
 - .2 Extruded Bars, Rods, Profiles, and Tubes: In accordance with ASTM B221/B221M, and ANSI H35.1 AA6063-T5 or T6, anodizing quality.
 - .3 Extruded Structural Pipe and Tubes: In accordance with ASTM B429, and ANSI H35.1 AA6061-T6 or AA6063-T6, anodizing quality.
 - .4 Structural Profiles: In accordance with ASTM B308/B308M, anodizing quality.
 - .5 Welding Rods and Bare Electrodes: CSA W59.2.
- .2 Steel Reinforcement: Coat steel with manufacturer's standard corrosion resistant primer applied immediately after surface preparation and pre-treatment, and as follows:
 - .1 Rolled Sheet or Strip: CSA G40.20/G40.21.
 - .2 Structural Shapes, Plates and Bars: CSA G40.20/G40.21.
- .3 Brackets and Reinforcements: Manufacturer's standard high strength aluminum with non-staining, nonferrous shims for aligning system components.
- .4 Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
 - .1 Use self-locking devices where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration.
 - .2 Reinforce members as required to receive fastener threads.

- .3 Use only concealed fasteners, unless use of exposed fasteners has been accepted in writing by the Consultant.
- .4 Finish exposed portions to match framing system.
- .5 Use slip joint linings, spacers, and sleeves at movement joints of material and type recommended by manufacturer.

- .5 Anchors: Three way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

- .6 Concealed Flashing: Manufacturer's standard corrosion resistant, non-staining, non-bleeding flashing compatible with adjacent materials.

- .7 Transition Membranes: Full length mechanically anchored, extruded silicone rubber transition membrane to perimeter of frame profile to provide continuous air/vapour retarder to adjacent wall construction:

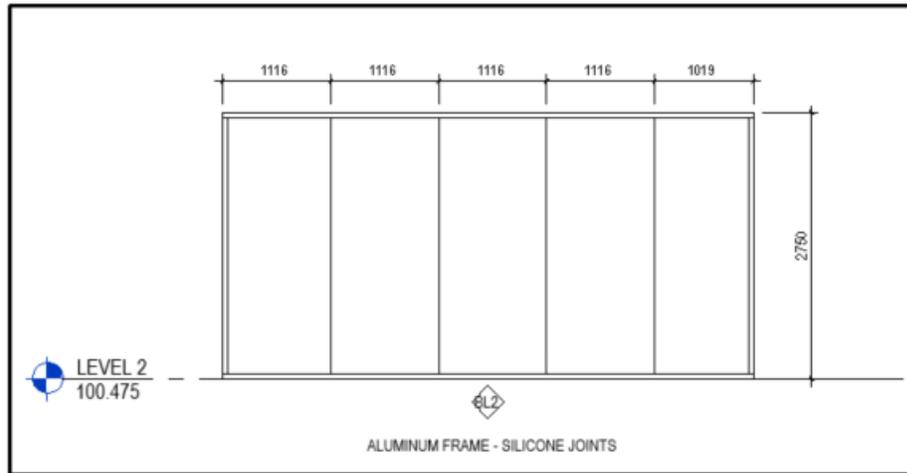
- .8 Glazing Gaskets: Manufacturer's standard sealed corner pressure glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers; as recommended by manufacturer for joint type.

- 2.4 Entrance Frames
 - .1 Manufacturer's extruded aluminum glazed doors for manual swing operation, reinforced as required to withstand traffic conditions.
 - .2 Door Type:
 - .1 Construction: wide stile, thermally broken.
 - .2 Dimensions: Nominal as indicated on Drawings.
 - .3 Glazing Method: Bevelled stops for single glazing and Square stops for sealed glazing, with non-removable glazing stops on outside of door.
 - .4 Acceptable Manufacturers:
 - .1 Kawneer 560 Series

- 2.5 Storefront Frames
 - .1 Manufacturer's standard extruded aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - .2 Exterior Frames: Refer to Section 08 44 13.
 - .3 Interior Vestibule Frame Type:
 - .1 Construction: Non-Thermal, pressure plate glazed.
 - .2 Dimensions: Nominal 65 mm face x 75 mm deep back frame profile with glazing throat to accommodate 25 mm sealed glazing unit. Confirm with details on Drawings.
 - .3 Cover Depth: Nominal 65 mm wide x 19 mm deep, or as indicated on Drawings
 - .4 Glazing Method: Glazed from exterior.
 - .5 Installation Method: Single span, storefront opening.
 - .6 Acceptable Manufacturers:
 - .1 Alumicor 3400 Series
 - .2 Kawneer 451T Series
 - .3 US Aluminum/CRL IT451 Series

- 2.6 Interior Aluminum framing
 - .1 Interior aluminum framing system with vertical butt sealed joints. Refer to Section 07 92 00 for sealants.
 - .2 Basis-of-Design:

- .3 Finish: Clear anodized finish; clear tempered glass.



- .4

2.7 Door Hardware

- .1 Refer to Section 08 71 00.

2.8 Sealants

- .1 Glazing Sealants: As recommended by manufacturer for joint type and as follows:

.1 Weather Seal Sealant:

- .1 ASTM C920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other system components with which it comes in contact; and recommended by structural and weather seal sealant and curtain wall manufacturers for this use.
- .2 Joint Movement Capability: Accommodate 50% increase or decrease in joint width at time of application when measured according to ASTM C719.
- .3 Colour: Matching structural sealant.
- .4 Acceptable Materials:
- General Electrical SSG4000.
 - Dow-Corning 995.
 - Tremco Spectrum 2.

2.9 Aluminum Finishes

- .1 Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- .2 Clear Anodized Finish: Confirm finishes with Consultant.
- .1 Class I Finish: Architectural Class I, clear coating 0.018 mm or thicker in accordance with AAMA 611.
- .2 Class II Finish: Architectural Class II, clear coating 0.010 mm or thicker in accordance with AAMA 611.

2.10 Accessories

- .1 Insulating Materials: Specified in Section 07 23 00.
- .2 Bituminous Paint: Cold applied asphalt mastic paint containing no asbestos, formulated for minimum 0.762 mm thickness per coat.

2.11 Fabrication

- .1 Form aluminum shapes before finishing.
- .2 Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish; remove weld spatter and welding oxides from exposed surfaces by de-scaling or grinding.
- .3 Fabricate framing member components first, have the following characteristics when fully assembled:
 - .1 Sharp and straight profiles, free of defects or deformations.
 - .2 Accurately fitted joints with ends coped or mitred.
 - .3 Drainage to allow water entering joints, condensation occurring within framing members, and moisture migrating within the system to flow to the exterior.
 - .4 Physical and thermal isolation of glass and glazing from framing members.
 - .5 Accommodations for thermal and mechanical movements of glass and glazing, and framing to maintain required glazing edge clearances.
 - .6 Provisions for site replacement of glazing.
 - .7 Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- .4 Fabricate storefront framing components using shear block system, screw spline system or head-and-sill receptor system with shear blocks at intermediate horizontal members to accommodate storefront loading requirements.
- .5 Reinforce door frames as required to support loads imposed by door operation and for installing hardware, and as follows:
 - .1 Provide compression weather stripping at fixed stops at exterior doors.
 - .2 Provide silencers at stops to prevent metal-to-metal contact at interior doors; install three silencers on strike jamb of single door frames and two silencers on head of frames for pairs of doors.
- .6 Reinforce entrance frames as required for installing hardware, and as follows:
 - .1 Provide sliding weather stripping retained in adjustable strip mortised into door edge at pairs of exterior doors.
 - .2 Provide weather sweeps applied to door bottoms at exterior doors.
- .7 Factory install hardware to the greatest extent possible; cut, drill, and tap for factory installed hardware before applying finishes.
- .8 Clearly mark components to identify their locations in Project in accordance with shop drawings after fabrication.

3. EXECUTION

3.1 Examination

- .1 Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

- .1 Install storefront and entrance framing in accordance with manufacturer's written instructions using materials free from damage and having tightly fitting joints to produce hairline joints free of burrs and distortion, rigidly secured to prevent movement within joints.
- .2 Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration; seal joints watertight except where required to allow for drainage of water from within framing system.
- .3 Protect aluminum against contact with concrete and dissimilar metals by painting contact surfaces with primer, by applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
- .4 Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- .5 Set continuous sill members and flashing in full sealant bed to produce weather tight installation.
- .6 Install components plumb and true in alignment with established lines and grades, without warp or rack.
- .7 Install insulation materials in accordance with Section 07 23 00, framing manufacturers requirements, and Consultant's requirements for a continuously insulated enclosure.
- .8 Install perimeter joint sealants in accordance with Section 07 92 00 to produce weather tight installation.
- .9 Install glass in accordance with Section 08 81 00.
- .10 Entrances:
 - .1 Install entrance framing to produce smooth operation and tight fit at contact points.
 - .2 Install exterior entrance framing to produce tight fit at weather stripping and weather tight closure.
 - .3 Install site applied surface mounted hardware in accordance with hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.3 Erection Tolerances

- .1 Install aluminum framed entrance and storefront systems in accordance with the following maximum tolerances:
 - .1 Location and Plane: Limit variation from true location and plane to 3 mm in 3660 mm; 6 mm over total length.
 - .2 Alignment:
 - .1 Limit offset from true alignment to 1.5 mm where surfaces abut in line.
 - .2 Limit offset from true alignment to 0.8 mm where surfaces meet at corners
 - .3 Diagonal Measurements: Limit difference between diagonal measurements to 3 mm.

3.4 Adjusting

- .1 Adjust operating hardware for smooth operation in accordance with hardware manufacturers' written instructions.
- .2 Adjust closers designated as accessible for people with disabilities to provide a 3 second closer sweep period for doors to move from a 70° open position to 75 mm from latch measured to the leading door edge.

- 3.5 Protection
- .1 Protect aluminum finishes and glazing during erection against disfiguration, contamination or damage by abuse or harmful materials.
 - .2 Install protective cover where exposure to damage is critical.
 - .3 Mark each light with large cross or other symbol to make glass obvious and noticeable to other trades after glass is installed, using substance that will not stain, mark or "shadow" glass either by itself or by reaction with sunlight, moisture or the environment; masking tape is not considered as a suitable material; replace glass units marked with masking tape.

END OF SECTION

1. General

1.1 Summary

- .1 Provide Curtain Wall and Glazed Assemblies in accordance with requirements of the Contract Documents.

1.2 Definitions

- .1 Delegated Design Professional Engineer: The professional engineer hired or contracted to the fabricator or manufacturer to produce delegated design submittals and shop drawings to meet the requirements of the Project, and registered in the province of the Work, and who is not the Consultant.
- .2 Equal Dimensions: Curtain wall assemblies indicating equal dimensions on the drawings shall be calculated to align with in-place structural elements followed by even division of the space between structural elements. This shall mean that curtain wall materials are evenly spaced between adjacent structural members, not necessarily evenly spaced across the entire wall assembly.

1.3 References

- .1 Harmonized North American Fenestration Standard, AAMA/WDMA/CSA 101/I.S.2/A440 – “NAFS North American Fenestration Standard / Specification for Windows, Doors and Skylights.
- .2 American Architectural Manufacturers Association (AAMA)/Window and Door Manufacturers Association (WDMA):
 - .1 ANSI/AAMA/NWDA 101/I.S.4, North American Fenestration Standard/Specification for Windows, Doors and Skylights.
 - .2 AAMA 910, Voluntary "Life Cycle" Specifications and Test Methods for AW Class Architectural Windows and Doors.
 - .3 CSA A440.2 – Fenestration Energy Performance; used to establish temperature index (I) value.
- .2 Aluminum Association (AA):
 - .1 Aluminum Design Manual
- .3 American Architectural Manufacturer's Association (AAMA):
 - .1 AAMA 501, Methods of Test for Exterior Walls
 - .2 AAMA 501.5, Test Method for Thermal Cycling of Exterior Walls.
- .4 American National Standards Institute (ANSI):
 - .1 ANSI A156.10, Power Operated Pedestrian Doors.
 - .2 ANSI H35.1/H35.1M, American National Standard Alloy and Temper Designation Systems for Aluminum
- .5 ASTM International (ASTM):
 - .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM B209/B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

- .3 ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .4 ASTM B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles (withdrawn)
 - .5 ASTM B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube. (withdrawn)
 - .6 ASTM C719, Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
 - .7 ASTM C920 Standard Specification for Elastomeric Joint Sealants
 - .8 ASTM D2000, Standard Classification System for Rubber Products in Automotive Applications
 - .9 ASTM D2287, Standard Classification System and Basis for Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
 - .10 ASTM E283, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - .11 ASTM E330/E330M, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - .12 ASTM E331, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
 - .13 ASTM E547, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference
 - .14 ASTM E2190, Standard Test Method for Insulating Glass Unit Performance and Evaluation

 - .6 CSA Group (CSA):
 - .1 CAN/CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CSA S157, Strength Design in Aluminum.
 - .3 CSA W59.2, Welded Aluminum Construction.
 - .7 The Society for Protective Coatings (SSPC)/National Association of Corrosion Engineers (NACE International):
 - .1 Surface Preparation Guidelines:
 - .1 SSPC-PS Paint 12, Cold-Applied Asphalt Mastic (Extra Thick Film).
- 1.4 Submittals
- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
 - .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings prepared by or under the supervision of the delegated design professional engineer detailing fabrication and installation of the Work. Prepare details at not less than 1:5 minimum scale. Indicate all materials and finishes. Details of curtain wall and adjacent construction to which work of this section will be attached, and adjacent work attached to work of this section, including but not limited to.
 - .1 Connections and anchor requirements
 - .2 Type, size and spacing of fastening devices

- .3 Design loads
 - .4 Connections to adjacent air and vapour membranes
 - .5 Internal drainage
 - .6 Sealant locations
 - .7 Seal of a professional engineer registered in the Province of the Work for details requiring structural design for load bearing, or life/health safety.
- .3 Samples: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for color and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Furnish samples for each finish and color required. Furnish sample finishes on the required metal, in 300 mm lengths of extrusion or 300 mm squares of sheet or plate, showing maximum range or variation in color and shade, and matching the Consultant's sample.
- .4 Delegated Design Submittals: Submit for Consultant's information. Furnish letters of commitment and compliance as follows.
- .1 Provide Letter of Commitment in conjunction with shop drawings, signed and sealed by the professional engineer required by the Work of this Section indicating the following are designed to the intent of the Building Code.
 - .1 Curtain wall connections to building structure.
 - .2 Curtain wall reinforcement.
 - .3 Deflection of members
 - .4 Glass thickness as it relates to glass area
 - .5 Structural sealants adhesion to and support of sealed glass units.
 - .2 Provide Letter of Compliance, signed and sealed by the professional engineer required by the Work of this Section indicating that connections, reinforcement and deflection criteria, and glass thickness of installed system is in compliance with the intent of the Building Code and reviewed shop drawings before declaration of Substantial Performance.
- 1.5 Quality Assurance
- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
 - .2 Qualifications:
 - .1 Firm producing and executing the work in this section shall have a minimum of ten consecutive years experience in work of similar scope and nature to that specified.
 - .2 Installer shall be prepared to prove to the Owner's satisfaction, that he has adequate facilities and skilled personnel suitable for design, engineering, detailing, fabrication and installation of the glazed wall assembly.
 - .3 Installer: Installer shall be capable of assuming delegated design engineering responsibility, performing Work of this Section and who is acceptable to manufacturer for the type of work specified.
 - .4 Delegated Design Professional: Retain a licensed Professional Engineer, registered in the Province of the Work, to design fabrication and erection of the Work of this Section in accordance with applicable Building Code and Contract Documents requirements including, but not limited to, the following.
 - .1 Seal and signature to shop drawings and design submittals.
 - .2 Site review of installed components.

- .3 Certifications: Provide the following during the course of the Work:
 - .1 Compliance Certification: Provide certificates from manufacturer indicating tested performance requirements required by Authorities Having Jurisdiction.
 - .4 Letters of Commitment and Compliance: Provide documents prepared by the delegated design professional engineer as recommended by APEGA's Responsibilities for Engineering Services for Building Projects.
 - .5 Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations Authorities Having Jurisdiction. Obtain necessary approvals from all such authorities.
- 1.6 Delivery, Storage And Handling
- .1 General: Deliver fabricated units and component parts to project site completely identified in accordance with erection diagrams. Store in dry protected location off ground in accordance with manufacturer's instructions. Protect from damage, including from weather and construction activities. Handle and store material in such that no damage will be done to the materials or to the work of other sections. Remove temporary protection after installation. Do not leave coating residue on any surface.
- 1.7 Warranty
- .1 Provide manufacturers written warranty, signed and issued in the name of Owner, to replace the following items for defective material and workmanship for the time stated from date of Substantial Performance:
 - .1 Framing, panels and glazing: Failure of performance requirements specified below; 2 years.
 - .2 Sealed glass units: misting, dusting and seal failure; as indicated in Section 08 81 00 – Glass Glazing.
 - .3 Joint sealants, caulking: Failure to maintain seal; 2 years.
 - .4 Structural sealants: adhesion to and support of sealed glass units: 20 years.
 - .5 Aluminum frame shapes: oil-canning and delaminations; 2 years.
 - .6 Finishes: Failure specified finishes not attributable to normal weathering; manufacturer's standard 2 year.
- 2. Products**
- 2.1 Design Criteria
- .1 System Design: Design and size components to withstand dead loads and live loads caused by positive and negative wind loads acting normal to plane of wall as calculated in accordance with the National Building Code as measured in accordance with ASTM E330 and NECB compliance.
 - .2 System Design: Design and size components, by a Professional Engineer registered in the Province of Manitoba, to withstand dead loads and live loads caused by positive and negative wind loads acting normal to plane of wall as calculated in accordance with National Building Code as measured in accordance with ASTM E330.
 - .3 Design and Size Components to Withstand:
 - .1 Dead loads and live loads caused by positive and negative wind loads acting normal to plane of wall to a design pressure of 0.95 kPa as measured in accordance with ASTM E330, and in accordance with NBC.

- .2 Seismic loads and sway displacement as calculated in accordance with NBC.
- .4 Limit mullion deflection to L/175; with full recovery of glazing materials.
 - .1 Design curtain wall to AAMA CW-DG-1.
 - .2 Design aluminum components to CAN/CSA S157
 - .3 Thermal Expansion: Ensure curtain wall system can withstand temperature differential of 95 degrees C over a twelve-hour period and is able to accommodate interior and exterior system expansion and contraction without damage to components or deterioration of seals.
 - .4 Provide system to accommodate, without damage to components or deterioration of seals:
 - .1 Movement within system.
 - .2 Movement between system and perimeter framing components.
 - .3 Dynamic loading and release of loads.
 - .4 Deflection of structural support framing.
 - .5 Shortening of building concrete structural columns.
 - .6 Creep of concrete structural members.
 - .7 A mid-span slab edge deflection as indicated on structural drawings.
- .5 Design vertical expansion joints with baffled overlaps and compressed resilient air seal laid between mullion ends.
- .6 Air Infiltration: Limit air infiltration through assembly to 0.03 L/s·m² of wall area, measured at a reference differential pressure across assembly of 300 Pa when tested in accordance with ASTM E283.
- .7 Vapour seal with interior atmospheric pressure of 25 mm sp, 22 degrees C, 40% HR: No failure.
- .8 Air and Vapour Seal: Maintain continuous air barrier and vapour retarder throughout assembly, primarily in line with inside pane of glass and heel bead of glazing compound. Position thermal insulation on exterior surface of air barrier and vapour retarder.
- .9 Water Leakage: None, when measured in accordance with ASTM E331.
- .10 Limit air infiltration through assembly to 0.0003 m³/s/m² (0.06 cfm/ft²) of wall area, measured at a reference differential pressure across assembly of 750 Pa as measured in accordance with ASTM E283.
- .11 Condensation Resistance (CRF): When tested to AAMA 1503, the condensation resistance factor shall not be less than 66 frame and 60 glass, based on 25 mm clear insulating glass, (1/4" glass, 1/2" air space, 1/4" glass).
- .12 Overall Thermal transmittance (U-Factor): Maximum 1.6 W/(m²·K). or as indicated in Building Envelope report.
 - .1 The overall thermal transmittance value of the aluminum window wall assembly shall be determined for the reference sizes listed in accordance with:
 - .1 CSA A440.2/A440.3 Fenestration Energy Performance /User Guide to CSA A440.2 Fenestration Energy Performance, or
 - .2 NRFC 100, Determining Fenestration Product U-Factors.

- .2 Overall thermal transmittance shall be based on geographic location Zone 8, in accordance with the National Energy Code.
 - .13 System Internal Drainage: Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to the exterior by a weep drainage network.
 - .14 Maintain continuous air barrier and vapour retarder throughout assembly, primarily in line with inside pane of glass and heel bead of glazing compound.
 - .15 Ensure no vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system occur.
 - .16 Reinforce curtain wall system to accommodate window washing guide rails. Provide anchors sufficiently rigid to resist loads caused by equipment platform, without damage to wall system, in accordance with Authority having Jurisdiction.
 - .17 Design glazed aluminum curtain wall to rain screen principles.
 - .1 Ensure horizontal members are sealed to vertical members to form individual compartments in accordance with rain screen principles.
 - .2 Ventilate and pressure equalize air spaces outside exterior surface of insulation to exterior.
 - .18 Structural Silicone Sealants:
 - .1 Sealant Design: Design structural sealant to withstand specified loads without breakage, loss, failure of seals, product deterioration, and other defects.
 - .2 Design Installed Sealant to Withstand:
 - .1 Dead loads and live loads caused by positive and negative wind loads acting normal to plane of wall as calculated in accordance with National Building Code in accordance with ASTM E330.
 - .2 Seismic loads and sway displacement as calculated in accordance with NBC.
 - .3 Movement from ambient temperature range of 49 degrees C.
 - .4 Movement and deflection of structural support framing.
 - .5 Water and air penetration.
 - .3 Compatibility: Ensure compatibility between sealants and aluminum and glass surfaces. Ensure edge deletion of applied coatings on insulation glass units.
- 2.2 Materials
- .1 Aluminum: Materials recommended by manufacturer for type of use and finish indicated, and as follows:
 - .1 Extruded Structural Pipe and Tubes: In accordance with ASTM B429, and ANSI H35.1 AA6061-T6 or AA6063-T6, anodizing quality.
 - .2 Sheet and Plate: In accordance with ASTM B209/B209M, and ANSI H35.1 AA1100-H14, or AA5005-H32 or H34, anodizing quality.
 - .3 Extruded Bars, Rods, Profiles, and Tubes: In accordance with ASTM B221/B221M, and ANSI H35.1 AA6063 T6, anodizing quality.
 - .4 Structural Profiles: In accordance with ASTM B308/B308M, anodizing quality.
 - .5 Welding Rods and Bare Electrodes: CSA W59.2.

- .2 Steel Reinforcement: Coat steel with manufacturer's standard corrosion resistant primer applied immediately after surface preparation and pre-treatment, and as follows:
 - .1 Rolled Sheet or Strip: CSA G40.20/G40.21.
 - .2 Structural Shapes, Plates and Bars: CSA G40.20/G40.21.
- .3 Brackets and Reinforcements: Manufacturer's standard high strength aluminum with non-staining, nonferrous shims for aligning system components.
- .4 Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
 - .1 Use self-locking devices where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration.
 - .2 Reinforce members as required to receive fastener threads.
 - .3 Use only concealed fasteners, unless use of exposed fasteners has been accepted in writing by the Consultant.
 - .4 Exposed fasteners stainless steel unless otherwise indicated.
 - .5 Finish exposed portions to match framing system.
 - .6 Use slip joint linings, spacers, and sleeves at movement joints of material and type recommended by manufacturer.
- .5 Anti-Rotation Channels: Extruded aluminum anti-rotation channel designed to mechanically retain air seal membrane to the face of the tubular back section.
- .6 Anchors: Three way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
- .7 Concealed Flashing: Manufacturer's standard corrosion resistant, non-staining, non-bleeding flashing compatible with adjacent materials.
- .8 Transition Membranes: Full length mechanically anchored, extruded silicone rubber transition membrane to perimeter of frame profile to provide continuous air/vapour retarder to adjacent wall construction.
- .9 Glazing Gaskets: Manufacturer's standard sealed corner pressure glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers; as recommended by manufacturer for joint type.
- .10 Thermal Barrier: two parallel, glass reinforced nylon strips forming continuous composite assembly.
- .11 Sealants:
 - .1 Structural Glazing Sealants: ASTM C1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
 - .1 Colour: Black.
 - .2 Primers, backing, bond breaker, and glazing accessories as recommended, compatible with structural sealant.
 - .2 Weatherseal Sealants and Backer Rods: As specified in Section 07 92 00.
 - .1 Colour: As selected by Consultant from manufacturers full range.

2.3 SSG Components

.1 Mullions:

- .1 Vertical and Horizontal Perimeter Frame Members: 64 mm sight line, nominal dimensions as indicated.
- .2 Pressure plates of sufficient size and strength to provide adequate bite on glass.
- .3 Pressure Plate Covers (Mullion Caps): Multiple sizes and profiles as indicated on the drawings.
- .4 Drainage holes, deflector plates and internal flashings to accommodate internal weep drainage system.
- .5 Reinforced Mullion: Of same size and profiles as vertical mullions, extruded aluminum cladding with internal reinforcement of shaped steel structural section.
- .6 Corners: Provide manufacturer's factory made 90-degree compatible inside and outside corners.
- .7 Sheet Metal Flashings, Closures and Trim: Sheet aluminum, minimum 0.635 mm thick (22 gauge), formed to sizes and profiles indicated. Finish to match curtain wall mullion sections. Secure with concealed fastening method.
- .8 Sheet Metal Air Barrier: Sheet aluminum, minimum 0.508 mm thick (24 gauge) formed to sizes and profiles indicated. Form sheet metal air barrier in maximum 2 400 mm lengths. Mill finish.

2.4 Auxiliary Materials

- .1 Sheet Metal for Metal Air/Vapour Barriers: Galvanized steel, ASTM A653/A653M, minimum 0.84 mm sheet steel, with minimum 380 g/m galvanized coating weight.
- .2 Zinc-Rich Primer for Touch-Up / Field Application: Solvent based, zinc rich coating. Minimum 79% zinc content in dried film. Provide for field repair of galvanized surfaces and select for compatibility with other paints used.

2.5 Framing Systems: Stick Built

- .1 Frame Type: Exterior curtain wall and punch windows: To profiles and thicknesses required to meet performance criteria; but not less than 3 mm thickness, and as follows:
 - .1 Frame Dimensions: As indicated on Drawings, as required to meet NECB compliance, and to accommodate triple glazing.
 - .2 Cover Depth: as detailed on Drawings, width to match frame x 19 mm deep, square profile.
 - .3 Acceptable Manufacturers:
 - .1 Alumicor TWF Thermawall 2600
 - .2 Kawneer 1600 UT Series

2.6 Glazing Systems

- .1 Glass: Specified in Section 08 81 00.
- .2 Glazing Gaskets: Manufacturer's standard sealed corner pressure glazing system of black, resilient elastomeric glazing gaskets, closed cell neoprene sponge, setting blocks, and shims or spacers.
 - .1 Interior glazing gaskets: black closed cell neoprene sponge in vision area.
 - .2 Exterior glazing gaskets and interior glazing gaskets at spandrel panel: black EPDM rubber.

- .3 Standard Glazing Sealants: As recommended by manufacturer for joint type.
- .4 Glazing Sealants: As recommended by manufacturer for joint type and as follows:
- .1 Weather Seal Sealant:
- .1 ASTM C920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other system components with which it comes in contact; and recommended by structural and weather seal sealant and curtain wall manufacturers for this use.
- .2 Joint Movement Capability: Accommodate 50% increase or decrease in joint width at time of application when measured according to ASTM C719.
- .3 Colour: Matching structural sealant.
- .4 Acceptable Materials:
- GE by Momentive SSG4000.
 - Dow-Corning 995.
 - Tremco Spectrum 2.
- 2.7 Accessory Materials
- .1 Bituminous Paint: Cold applied asphalt mastic paint in accordance with SSPC-Paint 12 requirements except containing no asbestos, formulated for 0.762 mm thickness per coat.
- 2.8 Operable Windows
- .1 High performance Window: Meets or exceeds the highest performance levels of CSA standard CAN/CSA-A440 windows:
- .1 Thermal Break: IsoPort™ 6mm separation consisting of one piece polyamide strip installed continuously and mechanically bonded to aluminum.
- .2 Seamless coupling mullion, unbroken weather joint on exterior surface
- .3 Provision for thermal movement
- .4 Simple joinery with overlapping flanges for economical construction and good weathering capability
- .5 Glazing: 25 mm sealed glazing units, installed and replaced from interior.
- .6 Exterior pre-shim butyl glazing tapes
- .7 Interior EPDM rubber glazing gaskets
- .8 Lock-in glass stop
- 2.9 Fabrication
- .1 Form aluminum shapes before finishing.
- .2 Fabricate components that have the following characteristics when assembled:
- .1 Sharp profiles, straight and free of defects or deformations.
- .2 Accurately fitted joints with ends coped or mitred.
- .3 Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- .4 Physical and thermal isolation of glazing from framing members.

- .5 Accommodations for thermal and mechanical movements of glazing and framing to prevent glazing-to-glazing contact and to maintain required glazing edge clearances.
 - .6 Provisions for re-glazing.
 - .3 Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish; remove weld spatter and welding oxides from exposed surfaces by de-scaling or grinding.
 - .4 Clearly mark fabricated components to identify their locations in accordance with Shop Drawings.
- 2.10 Aluminum Finishes
- .1 Unexposed aluminum: Mill finish.
 - .2 Anodized Finish: Clear anodized for interior framing and doors. Clear anodized for exterior caps.
 - .1 Class I Finish (Exterior Application): Architectural Class I, clear coating 0.018 mm or thicker in accordance with AAMA 611.
- 3. EXECUTION**
- 3.1 Examination
- .1 Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.
 - .2 Report immediately in writing to the consultant all discrepancies in accuracy and suitability which will adversely affect the work of this section. Report surfaces left unacceptable by other trades to the consultant before commencing installation.
- 3.2 Preparation
- .1 Supply anchorage devices and insects to the appropriate trades where required for building in or casting-in-place and instruct as to proper location and position
 - .2 Ensure that masonry and concrete surfaces to receive sealants are dry, firm, sound, smooth, suitable for bond, and free from loose material, projections, ice, frost, slick, grease, oil and other matter detrimental to bond.
- 3.3 Installation
- .1 Install in accordance with manufacturer's written instructions.
 - .2 Install components free from damage or irregularities.
 - .3 Fit joints to produce hairline joints free of burrs and distortion.
 - .4 Rigidly secure non-movement joints.
 - .5 Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

- .6 Weld components in concealed locations to minimize distortion or discoloration of finish:
- .7 Protect glazing surfaces from welding.
- .8 Protect work of other sections from welding.
- .9 Seal joints watertight, except where manufacturer's standard details indicate a requirement for open joints.
- .10 Metal Protection:
 - .1 Protect aluminum against galvanic action by painting contact surfaces with primer, by applying sealant or tape, or installing nonconductive spacers where aluminum contacts dissimilar metals.
 - .2 Protect aluminum against corrosion by painting contact surfaces with bituminous paint where aluminum contacts concrete or masonry.
- .11 Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- .12 Install components plumb and true in alignment with established lines and grades.
- .13 Install glass in accordance with manufacturer's standard glazing recommendations.
- .14 Install sealants in accordance with Section 07 92 00.
- .15 Install insulation materials in accordance with manufacturer's standard practices.
- .16 Install perimeter fire containment systems as specified in Section 07 84 00.
- .17 Erection Tolerances: Install glazed aluminum curtain wall systems in accordance with the following maximum tolerances:
 - .1 Plumb: 3 mm in 3050 mm; 6 mm in 12 m cumulative.
 - .2 Level: 3 mm in 3050 mm; 6 mm in 12 m cumulative.
 - .3 Alignment:
 - .1 Limit offset from true alignment to 1.5 mm where surfaces abut in line or are separated by reveal or protruding element up to 13 mm wide,
 - .2 Limit offset from true alignment to 3 mm where surfaces are separated by reveal or protruding element from 13 mm to 25 mm wide,
 - .3 Limit offset from true alignment to 6 mm where surfaces are separated by reveal or protruding element of 25 mm wide or greater.
 - .4 Location: Limit variation from plane to 3 mm in 3660 mm; 13 mm over total length.
- .18 Snap covers, profiles as indicated, and pressure plates shall be continuous from top to bottom of frame, with horizontals abutting between. Deep mullion caps to be corner mitred with horizontal shallow cap abutting deep mullion cap. All 19 mm and 50 mm deep caps, unless noted otherwise. Mechanically fasten glazing caps to pressure plates, one fastener for each section.

3.4 Cleaning

- .1 General: Wash to remove mortar, plaster, fireproofing and any other deleterious material from finished surfaces immediately. Cleaning and protective methods shall be carefully selected, applied and maintained so that finishes will not become uneven or otherwise impaired as a result of unequal exposure to light and weathering conditions.

END OF SECTION

1. GENERAL

1.1 Description:

- .1 Furnish labor, materials and other services to complete the fabrication of new fiberglass windows, including all materials required for the supply and installation of the units in the manner, direction and performance shown on the design drawings and specified herein.
- .2 Fiberglass window framing to incorporate a drained and vented system with complete air, vapor and moisture seals, allowing water entering the framing to drain to the exterior.
- .3 Fiberglass inswing windows and doors to be glazed with an interior air seal using a continuous silicone heel bead from the IGU to the sash frame.
- .4 Fiberglass inswing windows and doors to incorporate a concealed hinge system with a continuous interior air seal, uninterrupted by any hardware.
- .5 Drawings and specifications for work of this section are based upon fiberglass windows manufactured by Cascadia Windows Ltd. #101 – 5350B 275 Street, Langley, BC, Canada (web: www.cascadiawindows.com).

1.2 Testing And Performance:

- .1 Air Tightness:
 - .1 Air infiltration rate at a static air pressure differential of 1.6 psf when tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440-11 and ASTM E283.
 - .1 Fixed Windows: 0.00 cfm/ft² (0.00 L/s.m²).
 - .2 Operable windows and swing doors: A3 rating or better.
 - .2 Water Penetration Resistance:
 - .1 Laboratory Testing
 - .1 There shall be no water infiltration at a static air pressure differential as follows when tested in accordance with AAMA 101 and ASTM E331.
 - .2 Water penetration resistance test pressure for all vent types, including: Fixed windows, casement, awning, tilt & turn, hopper, inswing doors, and outswing doors: 15 psf (720 Pa).
 - .2 Field Testing:
 - .1 Windows shall have no water infiltration at a cyclic static air pressure difference at 12 psf (575 Pa) when tested in accordance with AAMA 101 and ASTM E1105.
- .3 Structural Requirements:
 - .1 Performance Grade (PG) and Class of all windows and doors shall be:
 - .1 For fixed windows, CW-95 or higher
 - .2 For operable window (inswing or outswing), CW-45 or higher
 - .3 For swinging doors (inswing or outswing), CW-35 or higher
 - .2 Components and cladding design wind pressure (DP) for the project of: ## PSF (or #### Pa) – ASD calculation method (not factored). Use this design wind pressure for the design or mullions, reinforcing, and other spanning members.
 - .1 Design glass according to AAMA/WDMA/CSA 101/I.S.2/A440-11
 - .2 Design fiberglass according to AAMA/WDMA/CSA 101/I.S.2/A440-11.

- .3 Design glazing and spanning window frame members, including any required reinforcing, in accordance with AAMA/WDMA/CSA 101/I.S.2/A440-11. There shall be no deflection in excess of L/175 of the span of any framing member.
 - .4 Allow for deflection of building structure. Ensure no structural loads are imposed on window assemblies. In lieu of other specific requirements the minimum requirements are as specified by the structural engineer.
- .4 Thermal Requirements
- .1 The Thermal Transmittance U-Value shall be certified in accordance with the National Fenestration Rating Council (NFRC).
 - .1 Overall U-values, utilizing double glazed IG units:
 - .1 Windows - fixed and operable: 0.25 (Imperial) / 1.4 (Metric)
 - .2 Doors – inswing, outswing, and sliding: 0.23 (Imperial) / 1.3 (Metric)
 - .2 Overall U-values, utilizing triple glazed IG units, incorporating two LowE coatings:
 - .1 Fixed windows = 0.15 (Imperial) / 0.85 (Metric)
 - .2 Tilt & Turn windows = 0.15 (Imperial) / 0.85 (Metric)
 - .3 Hopper windows = 0.15 (Imperial) / 0.85 (Metric)
 - .4 Casement = 0.15 (Imperial) / 0.85 (Metric)
 - .5 Awning = 0.15 (Imperial) / 0.85 (Metric)
 - .6 Inswing, Outswing, and Sliding Doors = 0.15 (Imperial) / 0.85 (Metric)
 - .2 Energy Star: Windows must be ENERGY STAR® certified. Window manufacturer must provide required documentation and labeling.
- .5 Warranties
- .1 Provide manufacturers standard express limited warranty on fiberglass frame components for a period of 20 years for workmanship and materials.
 - .2 Provide manufacturers standard express limited warranty on integral hardware for a period of 10 years for workmanship and materials.
 - .3 Provide manufacturers standard express warranty for the insulated glass units to cover premature hermetic seal failure (condensation between the lites at normal service temperatures) appearing within a period of 10 years from the date of substantial completion.
 - .4 Provide data for maintenance and cleaning in accordance with instructions under General Conditions.

2. PRODUCTS

2.1 Manufacturers:

- .1 Fiberglass Windows and Doors shall be manufactured by:
 - .1 Cascadia Windows and Doors
 - .2 Or other pre-approved manufacturer.

2.2 Materials:

- .1 All frame and sash profiles are made from Pultruded Fiberglass.
 - .1 Pultrusions shall be manufactured with clamp-action equipment. No surface texture from rollers is permitted.
 - .2 Glass content average for pultruded profiles: 55% or more.
- .2 Fasteners shall be 300 series stainless steel, 400 series stainless steel, or Leland Industries DT2000 coated of sufficient size and quantity to perform their intended function.

- .1 Fastener corrosion resistance shall be: 2000 hours minimum, when tested in accordance with ASTM B117.
- .3 Glazing tape: black, closed cell copolymer, polyethylene foam coated with an aggressive acrylic adhesive. All upward facing exterior horizontal joints to have an additional cap bead of neutral cure silicone.
- .4 Internal sealants for frame joints and continuous heel beads: 1199 DOW Corning sealant, or equal or better neutral cure silicone sealant.
- .5 Insulated Glazing Units: Insulated glazing unit certified by IGMA. Glass thickness shall be in accordance with applicable Building Codes, but not less than 4mm. All insulated glass units shall be argon filled and utilize soft coat metallic low-E coating(s). Edge construction to consist of a primary seal of polyisobutylene; a tubular low conductivity stainless steel spacer-bar with sealed corners, filled with desiccant; and a secondary seal of neutral cure silicone. Performance requirements indicated in this section are for center-of-glass.
- .6 Low-E coated, grey tint, insulated glazing units (triple glazed):
 - .1 LowE coating, on #2 & #5 surfaces, argon filled. Refer to Section 07 02 00. SHGC 0.40. U effective U-0.15 (USI 0.85), ,
 - .2 Tempered glass in insulated glazing units:
 - .1 Where required by local building code or bylaw, and additionally as indicated in the construction documents.
- .7 Hardware
 - .1 All hardware to be supplied by a single manufacturer: Approved manufacturer: Roto Frank of America.
 - .2 Casement and Awning windows: RotoSil nano corrosion resistant finish, rotary hardware with folding handle.
 - .3 Tilt & Turn and Hopper windows: RotoSil nano corrosion resistant finish, multi-point locking hardware.
 - .4 Hardware finish: Colour to be selected from supplier's standard range.
- .8 Finish: Hydro Tuff two-component waterborne polyurethane, meeting the requirements of AAMA-625.
 - .1 Interior Frame Finish: Consultant to choose from manufacturer's standard color range.
 - .2 Exterior Frame Finish: grey to match look of clear anodized aluminum framing.
- .9 Glazing Stop
 - .1 Provide manufacturer pultruded fiberglass glazing stops as required by IGU thickness.
 - .2 Lock-in, screw-less type.
 - .3 No PVC materials shall be used for glazing stop or related accessories.

3. EXECUTION

3.1 Fabrication:

- .1 Fabricate framing from pultrusion of size and shape shown on shop drawings.
- .2 All framing joints shall be accurately machined, assembled, and sealed to provide neat weather-tight connections.
- .3 Provide interior heel bead as required for rain screen system.
- .4 All glazing pockets shall be vented, pressure equalized and drained to the exterior.

3.2 Installation:

- .1 Windows shall be installed, glazed and adjusted by experienced personnel in accordance with the manufacturer's instructions and approved shop drawings.
- .2 All items in this section shall be set level, square, plumb and at proper elevations and in alignment with other work.
- .3 Install windows in accordance with approved shop drawings.

3.3 Protection And Cleaning:

- .1 Windows shall be isolated and protected from concrete, mortar, plaster and other Building materials during and after installation until acceptance by the General Contractor. Thereafter, it shall be the responsibility of the General Contractor to maintain protection and provide final cleaning.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide door hardware in accordance with requirements of Contract Documents.

1.2 References

- .1 American National Standards Institute (ANSI)/Builders Hardware Manufacturers Association (BHMA):
- .1 ANSI A117.1, Accessible and Usable Buildings and Facilities.
 - .2 ANSI/BHMA A156.10, Power Operated Pedestrian Doors.
 - .3 ANSI/BHMA A156.18, American National Standard for Materials and Finishes.
 - .4 ANSI/BHMA A156.19, Power Assist and Low Energy Power Operated Doors
- .2 Builders Hardware Manufacturers Association (BHMA):
- .1 BHMA, Certified Products Directory.
- .3 Door and Hardware Institute (DHI):
- .1 DHI SFHS, Sequence and Format for the Hardware Schedule.
 - .2 ANSI/DHI A115.IG, Installation Guide for Doors and Hardware.

1.3 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
- .2 Hardware Schedule: Submit for Consultant's action. Furnish a list of manufacturers and hardware items. Submit typed hardware schedule in a vertical format. Schedule hardware items for each door separately. List hardware and describe each piece with manufacturer's numbers. The schedule shall list each opening in individual headings and by item number sequence. Each opening shall be listed with location, door and frame size, door and frame materials, hand of door, degree of opening, fire label identification and other special details of the opening. The Consultant's original scheduled hardware set numbers shall be included in the item heading details. Keying information shall be listed in a separate column of the vertical format.
- .3 Samples: Submit for Consultant's action. Furnish in conjunction with hardware schedule. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for colour and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Furnish samples of the following.
- .1 Finish Samples: Furnish samples of each type of finish required for hardware. Make samples not less than 100 x 150 mm plate size. Distribute the acceptable samples to the item manufacturers for purposes of matching.
 - .2 Hardware Samples: Furnish 1 sample of each typical item of hardware to be exposed in the Work. Deliver the acceptable samples to the job site for comparison with the hardware delivered for installation.
- .4 Closeout Submittals: Submit for Owner's documentation.
- .1 Warranty.
 - .2 Maintenance data.

1.4 Quality Assurance

- .1 Supplier Qualifications: Recognized architectural finish hardware supplier, with warehousing facilities, who has been providing hardware for period of not less than 10 years in the Province of Alberta or Yukon Territory. The supplier shall be, or employ, a certified Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC) currently registered in the continuing education program as administered by the Door and Hardware Institute (DHI). The hardware schedule shall be prepared, stamped, and signed by a certified AHC/EHC. Submissions without this stamp and signature will be rejected.
- .2 Installer Qualifications: Firm with 3 years experience in installation of similar hardware to that required for this project, including specific requirements indicated. Must be certified to install integrated access control locks by the specified manufacturer.
- .3 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- .4 Fire-Rated Assemblies: Comply with the requirements of NFPA 80. For fire-rated doors and frames, provide only hardware which is labeled by ULC for the required fire-resistance ratings and complies with the label requirements of the doors and frames.
- .5 Manufacturing Compliance: Use only products listed in the BHMA Directory of Certified Products for hardware of this Project.
- .6 Templates: Manufacture finish hardware to templates, and furnish hardware with fasteners of proper type to suit door and frame details. Furnish templates and schedules to door and frame manufacturers and other trades requiring same, so that doors and frames can be cut, reinforced and otherwise prepared in the shop to receive hardware.
- .7 Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of National, Provincial and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.
- .8 Performance Requirements: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated, and generally comply with the following provisions:
 - .1 Accessibility requirements in accordance with ANSI 117.1.
 - .2 Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
 - .3 Door Closers: Maximum opening force requirements as follows:
 - .1 Interior Hinged Doors: Nominal 20 N applied perpendicular to door.
 - .2 Sliding or Folding Doors: Nominal 20 N applied parallel to door at latch.
 - .3 Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - .4 Thresholds: Maximum 13 mm high; bevel raised thresholds with a slope of maximum 1:2.
 - .5 Latches, Locks, and Exit Devices: Nominal 65 N to release the latch, and shall not require the use of a key, tool, or special knowledge for operation.
 - .6 Delayed-Egress Locks: Lock releases within 15 seconds after applying a force nominal 90 N.
 - .7 Door Closers: Nominal 130 N to set door in motion and nominal 65 N to open door to minimum required width.

1.5 Delivery, Storage and Handling

- .1 General: Package and label each item of hardware separately. Tag each item in accordance with the final hardware schedule. Each package shall contain appropriate fastenings, instructions and installation templates. Protect all items from loss or damage in shipment. Store hardware items at the site in a locked space to prevent loss. Apply to doors as recommended by hardware manufacturer and as required. Fit hardware in the respective doors and remove before painting. Reinstall after painting of doors is completed. Upon completion, adjust and lubricate hardware for proper operation.

1.6 Warranty

- .1 Special Warranty: Submit for Owner's documentation. Furnish 5 year written warranty in form stipulated by Consultant, signed by the Contractor and Installer, agreeing to repair or replace Work which has failed as a result of defects in materials or workmanship. Upon notification of such defects, within the warranty period, make necessary repairs or replacement at the convenience of the Owner. Other guarantees or warranties may not be substituted by the Contractor for the terms of this special warranty.

1.7 Maintenance

- .1 Maintenance and Operating Manuals: Submit for Owner's documentation. Furnish complete manuals describing the materials, devices and procedures to be followed in operating, cleaning and maintaining the Work. Include manufacturers' brochures and parts lists describing the actual materials used in the Work. Assemble manuals for component parts into single binders identified for each system.
- .2 Maintenance Service: Approximately 6 months after the acceptance of hardware in each area, the Installer and the representative of the lock manufacturer, shall return to the project and re-adjust every item of hardware to restore proper function of doors and hardware. Consult with Owner's personnel and furnish instruction in recommended additions to the maintenance procedures. Replace hardware items which have deteriorated or failed due to faulty materials or installation of hardware units. Furnish a written report of current and predictable significant problems in the performance of the hardware.

2. PRODUCTS

2.1 Scheduled Door Hardware

- .1 Provide door hardware for each door in accordance with requirements in this Section, door hardware sets indicated in door, frame and hardware schedule on Drawings.

2.2 Automatic Swing Door Operators

- .1 Coordinate the work of all trades, including glass and glazing, masonry, and electrical requirements covered in manufacturer's details and appropriate sections of the specifications.
- .2 The electrical contractor shall provide 117 volt, 60 cycle, single phase 15 ampere service for 1-2 operators, 30 ampere service for 3-4 operators, and as follows:
 - .1 Coordinate with electrical contractor for provision of service to each operator from junction box for multiple operators.
 - .2 Coordinate with electrical contractor shall provide electrical conduit and wiring from specified controls to operators as outlined on manufacturer's drawings.
- .3 Finish hardware supplier shall Provide and install concealed electro-mechanical swing door operator, consisting of electro-mechanical swinging door operator and electronic control, aluminum header, connecting hardware, and power on/off switch and safety sensor, and as follows:
 - .1 Automatic entrance equipment: comply with ANSI A156.10 or A156.19.
 - .2 Aluminium header extrusions: minimum nominal 4 mm wall thickness with finish anodized AA-M12-C22-A31 clear.
 - .3 Equipment must operate between -35°C and +55°C in all climate conditions.
 - .4 Operator: Electro-mechanical system installed in a header to resist dust, dirt and corrosion; entire operator shall be removable from the header as a unit.
 - .5 Bearings: Fully lubricated and sealed to minimize wear and friction.

- .4 Operator shall open the door with a 1/8 HP motor through reduction gears, door arm, and linkage assembly, and as follows:
 - .1 Low energy operator, door opening time: not be less than 4 seconds.
 - .2 The drive train shall have a positive, constant engagement. The operator shall stop the door in the open position by electrically reducing the motor voltage and stalling against a 90° stop.
 - .3 Close the door by spring energy; controlled by employing the motor as a dynamic brake.
 - .4 Door closing time shall not be less than 4.5 seconds.
 - .5 Pre-load closing spring for positive closing action at a low material stress level for long spring life.
 - .6 Provide obstruction detection to reverse door when closing if an object stops the door and to stop door from opening if object is detected on swing side.
 - .7 The operator shall function as a manual door closer in the direction of swing with or without electrical power.
 - .5 The door forces and speeds generated during power opening, and manual opening in both directions of swing, and spring closing in both directions of swing shall conform to the requirements of ANSI A156.10 or A156.19.
 - .6 Verify that no defects or errors are present in completed phases of the work that would result in poor application or installation, or cause latent defects of the automatic door equipment.
 - .7 Installation and warranty adjustments shall be performed by authorized distributors' factory trained technician.
- 2.3 Fasteners
- .1 Supply all necessary screws, bolts and other fasteners of suitable size and type to adequately and permanently secure hardware in place.
 - .2 Fasteners shall be of same material and finish as hardware.
 - .3 Use fasteners that are compatible with materials through which they pass.
- 2.4 Hardware Finishes
- .1 Conform to ANSI/BHMA A156.18, Recommended Practices for Materials and Finishes.
- 2.5 Keying
- .1 Nomenclature shall conform to the American Society of Architectural Hardware Consultants handbook entitled "Keying"
 - .2 Form keys from nickel silver.
 - .3 Furnish two change keys for each lock except where noted otherwise.
 - .4 Keying System:
 - .1 Establish a Great Grand Master keying system utilizing a 6 increment
 - .2 Pin tumbler system.
 - .3 Key doors to same rooms or areas alike.
- 3. EXECUTION**
- 3.1 Examination
- .1 Examine doors and frames, with installer present, for compliance with requirements for installation tolerances, labelled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

- .2 Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
 - .3 Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.2 Preparation
- .1 Steel Doors and Frames: Comply with DHI A115 series.
 - .2 Wood Doors: Comply with DHI A115-W series.
- 3.3 Installation
- .1 Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required in accordance with governing regulations:
 - .1 Standard Steel Doors and Frames: DHI's Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
 - .2 Custom Steel Doors and Frames: DHI's Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.
 - .3 Wood Doors: DHI WDHS.3, Recommended Locations for Architectural Hardware for Wood Flush Doors.
 - .2 Install each door hardware item in accordance with manufacturer's written instructions.
 - .3 Coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way.
 - .4 Do not install surface mounted items until finishes have been completed on substrates involved, and as follows:
 - .1 Set units level, plumb, and true to line and location.
 - .2 Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - .3 Drill and countersink units that are not factory prepared for anchorage fasteners.
 - .4 Space fasteners and anchors according to industry standards.
 - .5 Key Control System: Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.
 - .6 Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings; verify location with Consultant, and as follows:
 - .1 Configuration: Provide one power supply for each door opening.
 - .7 Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant in accordance with requirements specified in Section 07 92 00.
- 3.4 Site Quality Control
- .1 Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 - .2 Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted, and as follows:
 - .1 Testing: Consists of Dynamic, static and system tests.

- .2 Dynamic tests shall be conducted to before terminating devices to ensure door mechanics, sensors and locking devices mechanically functions correctly and free of grounds and shorts.
- .3 Static tests shall be conducted before interconnecting devices to ensure all equipment functions correctly when energized.
- .4 System tests shall be conducted to test system fully and to include fire alarm integration.

3.5 Adjusting

- .1 Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and in accordance with referenced accessibility requirements:
 - .1 Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
 - .2 Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 - .3 Door Closers: Adjust sweep period so that, from an open position of 70°, the door will take at least 3 seconds to move to a point 75 mm from the latch, measured to the leading edge of the door.
- .2 Six Month Adjustment: Approximately six months after date of Substantial Performance, perform the following:
 - .1 Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
 - .2 Consult with and instruct Owner's personnel on recommended maintenance procedures.
 - .3 Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.6 Cleaning and Protection

- .1 Clean adjacent surfaces soiled by door hardware installation.
- .2 Clean operating items as necessary to restore proper function and finish.
- .3 Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.7 Demonstration

- .1 Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.8 Door Hardware Schedule

- .1 Hardware groups as indicated below, coordinate with Door Schedule on Drawings, and other sections affected by hardware groupings.
- .2 Door Index:

Legend:
⚡ Electrified Opening

Door#	HwSet#
EXP1H008.A⚡	001
EXP1001.A⚡	002
EXP1002.A⚡	001
EXP1004.B⚡	002
EXP1009.A⚡	003
EXP1021.A⚡	002
EXP1027.A⚡	004
EXP1028.A	005
EXP1029.A⚡	006
EXP1051.A⚡	002
EXP1058.A⚡	002
SB1H009.A⚡	007
SB1001.A⚡	008
SB1002.A	009
SB1004.A⚡	008
SB1005.A⚡	010
SB1006.A	011
SB1007.A⚡	012
SB1008.A⚡	012
SB1009.A⚡	013
SB1012.A⚡	012
SB1013.A	014
SB1013.B	014
SB1013.C	015
SB1013.D	015
SB1014.A	016
SB1015.A	014
SB1015.B	014
SB1015.C	014
SB1015.D	015
SB1016.A⚡	012
SB1017.A⚡	012
SB1018.A⚡	012
SB1019.A⚡	012
SB1021.A⚡	008
SB1022.A⚡	012
SB1022.B⚡	012
SB1023.A⚡	017
SB1024.A⚡	018
SB1025.A⚡	012
SB1026.A⚡	019
SB1026.B⚡	019

Door#	HwSet#
SB1026.C⚡	019
SB1028.A	020
SB1029.A	020
SB1030.A	020
SB1030.B	021
SB1031.A	022
SB1032.A⚡	017
SB1032.B⚡	012
SB1032.C⚡	017
SB1034.A⚡	023
SB1035.A⚡	012
SB1036.A⚡	012
SB1037.A⚡	012
SB1038.A⚡	012
SB1039.A⚡	023
SB1040.A⚡	012
SB1041.A⚡	023
SB1043.A	016
SB1044.A⚡	012
SB1045.A⚡	012
SB1049.A⚡	012
SB1051.A⚡	008
SB1052.A	014
SB1052.B	014
SB1052.C	014
SB1052.D	014
SB1052.E	014
SB1052.F	015
SB1052.G	014
SB1053.A⚡	012
SB1054.A⚡	017
SB1054.B⚡	012
SB1055.A	014
SB1056.A	014
SB1057.A⚡	012
SB1058.A⚡	008

Remainder of page left blank – refer to attached hardware groups

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Legend:

 Link to catalog cut sheet

 Electrified Opening

Hardware Group No. 001 - 15 SECONDS DELAYED EGRESS

For use on Door #(s):

EXP1H008.A EXP1002.A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 127X114MM NRP		630	IVE
1	EA	POWER TRANSFER	EPT10 CON		 689	VON
1	EA	DELAYED PANIC HARDWARE	CX98-EO-4'-CON 24 VDC		 626	VON
1	EA	CONSTRUCTION KEYED MORTISE CYLINDER	64-42		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	EA	WEATHERSTRIPPING, SET	485A (1XW, 2XH)		A	ZER
1	EA	ASTRAGAL	43SP X DH		SP	ZER
1	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	THRESHOLD	626A-223 X OPENING WIDTH		A	ZER
1	EA	WIRE HARNESS	CON____(SIZE TO SUIT)			SCH
1	EA	WIRE HARNESS	CON-6W			SCH
1	EA	DPDT DOOR POSITION SWITCH	SD-84C		 WHT	
1	EA	POWER SUPPLY	PS902 FA900 KL900 120/240 VAC		 LGR	SCE

DELAYED PANIC HARDWARE MUST BE CONNECTED TO THE FIRE ALARM AND WILL UNLOCK FOR EXISTING WHEN THE FIRE ALARM IS ACTIVATED ON STAGE 2 ALARM OR ON POWER OUTAGE.

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Hardware Group No. 002 - CARD READER, AUTO OPERATOR

For use on Door #(s):

EXP1001.A EXP1004.B EXP1021.A EXP1051.A EXP1058.A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 127X114MM NRP		630	IVE
2	EA	POWER TRANSFER	EPT10 CON		⚡ 689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB		689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-35A-EO-CON 24 VDC		⚡ 626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-35A-NL-OP-388-CON- CYL 24 VDC		⚡ 626	VON
1	EA	CONSTRUCTION KEYED RIM CYLINDER	64-34		626	SAR
2	EA	CONSTRUCTION KEYED MORTISE CYLINDER	64-42		626	SAR
3	EA	I/C CYLINDER	6300		626	SAR
2	EA	90 DEG OFFSET PULL	8190EZHD 305MM STD		630- 316	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100S ADJ USE WITH 4642L OPERATOR		630	GLY
1	EA	SURFACE CLOSER	TJ4040XP LONG		689	LCN
1	EA	SURF. AUTO OPERATOR	4642 LONG CS WMS 120 VAC		⚡ 689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ		689	LCN
2	EA	ACTUATOR, TOUCH	8310-836T		630	LCN
1	EA	SEAL SET	WEATHERTRIP BY ALUMINUM DOOR & FRAME SUPPLIER			
2	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	THRESHOLD	626A-223 X OPENING WIDTH		A	ZER
1	EA	ADVANCED LOGIC RELAY	CX-33			CAM
2	EA	WIRE HARNESS	CON____(SIZE TO SUIT)		⚡	SCH
2	EA	WIRE HARNESS	CON-6W		⚡	SCH
1	EA	KEY SWITCH	653-0405 NS L2 ATS 12/24 VDC		⚡ 626	SCE
2	EA	DPDT DOOR POSITION SWITCH	SD-84C		⚡ WHT	
1	EA	POWER SUPPLY	PS904 BBK 900-4RL KL900 120/240 VAC		⚡ LGR	SCE
1		CARD READER	WORK OF DIVISION 28			

WIRE KEY SWITCH TO EXTERIOR ACTUATOR. THIS WILL BE USE TO ENERGIZE OR DISABLE THE ACTUATOR AT STAFF DISCRETION.

QEL PANIC HARWDARE MAY BE TIMED TO LOCK/UNLOCK TO SPECIFIC TIMES.

VALID CREDENTIALS WILL MOMENTARILY ENERGIZE THE EXTERIOR ACTUATOR, SHUNT THE DOOR CONTACTS AND RETRACT THE LATCH IN THE PANIC HARDWARE ALLOWING THE DOOR TO BE PULLED OPEN, OR IF DESIRE, PRESSING THE ACTUATOR WILL ACTIVATE THE AUTOMATIC DOOR OPERATOR.

FREE EXITING BY PRSSING PUSH PAD ON PANIC HARDWARE.

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Hardware Group No. 003 - CARD READER

For use on Door #(s):

EXP1009.A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 127X114MM NRP		630	IVE
1	EA	POWER TRANSFER	EPT10 CON		⚡ 689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-35A-NL-OP-388-CON- CYL 24 VDC		⚡ 626	VON
1	EA	CONSTRUCTION KEYED RIM CYLINDER	64-34		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	90 DEG OFFSET PULL	8190EZHD 305MM STD		630- 316	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	TJ4040XP LONG		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ		689	LCN
1	EA	SEAL SET	WEATHERTRIP BY ALUMINUM DOOR & FRAME SUPPLIER			
1	EA	ASTRAGAL X FH	SUPPLY BY ALUMINUM DOOR SUPPLIER			
1	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	THRESHOLD	626A-223 X OPENING WIDTH		A	ZER
1	EA	WIRE HARNESS	CON____(SIZE TO SUIT)		⚡	SCH
1	EA	WIRE HARNESS	CON-6W		⚡	SCH
1	EA	DPDT DOOR POSITION SWITCH	SD-84C		⚡ WHT	
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC		⚡ LGR	SCE
1		CARD READER	WORK OF DIVISION 28			

**VALID CREDENTIALS WILL MOMENTARILY SHUNT THE DOOR CONTACT AND RETARCT THE
LATCH IN THE PANIC HARDWARE.
FREE EXITING BY PRESSING PUSH PAD ON PANIC HARDWARE.**

**YUKON UNIVERSITY
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Hardware Group No. 004 - CARD READER

For use on Door #(s):
EXP1027.A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
5	EA	HINGE	5BB1HW 127X114MM NRP		630	IVE
1	EA	ELECTRIC HINGE	5BB1HW 127X114MM CON TW8	⚡	630	IVE
1	EA	CONST LATCHING BOLT	FB51P		630	IVE
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	ELECTRIC LOCK	64-82271-LNJ		⚡ 626	SAR
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	4040XP EDA		689	LCN
2	EA	ARMOR PLATE	8400 900MM X 25MM LDW B-CS		630	IVE
1	EA	WEATHER STRIPPING	485A X 2/DW X 2/DH		AL	ZER
1	EA	ASTRAGAL	43SP X DH		SP	ZER
2	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	THRESHOLD	626A-223 X OPENING WIDTH		A	ZER
1	EA	DOOR VIEWER	595		626	VFY
2	EA	DPDT DOOR POSITION SWITCH	SD-84C		⚡ WHT	
1		CARD READER	WORK OF DIVISION 28			
1		POWER SUPPLY	WORK OF DIVISION 28			

VALID CREDENTIALS WILL MOMENTARILY SHUNT THE DOOR CONTACT AND UNLOCK THE ELECTRIC LOCK.

Hardware Group No. 005

For use on Door #(s):
EXP1028.A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	PADLOCK	60-858		626	ASA
1	EA		BALANCE OF HARDWARE BY ROOF HATCH DOOR SUPPLIER			

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Hardware Group No. 006

For use on Door #(s):
EXP1029.A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 127X114MM NRP		630	IVE
1	EA	POWER TRANSFER	EPT10 CON		⚡ 689	VON
1	EA	ELEC PANIC HARDWARE	RX-XP98-NL-CON		⚡ 626	VON
1	EA	CONSTRUCTION KEYED RIM CYLINDER	64-34		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	EA	WEATHERSTRIPPING, SET	485A (1XW, 2XH)		A	ZER
1	EA	ASTRAGAL	43SP X DH		SP	ZER
1	EA	DOOR SWEEP	8192AA X DR WIDTH		AA	ZER
1	EA	THRESHOLD	626A-223 X OPENING WIDTH		A	ZER
1	EA	DPDT DOOR POSITION SWITCH	SD-84C		⚡ WHT	

Hardware Group No. 007 - CARD READER LOCK

For use on Door #(s):
SB1H009.A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 127X114MM		652	IVE
1	EA	AUTO FLUSH BOLT	FB31P		630	IVE
1	EA	DUST PROOF STRIKE	DP1		626	IVE
1	EA	CREDENTIAL READER MORTISE LOCK	64-IN100-82271-BIPS-B-LNJ		⚡ 626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	COORDINATOR	COR X FL		US26D	IVE
2	EA	MOUNTING BRACKET	MB1 OR MB2		BLK	IVE
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	4040XP EDA		689	LCN
2	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	SET	GASKETING	8303AA-S X 1/DW X 2/DH		AA	ZER
2	EA	DOOR BOTTOM	361AA X DW		AA	ZER
1	EA	ASTRAGAL	43SP X DH		SP	ZER

**YUKON UNIVERSITY
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Hardware Group No. 008 - AUTO OPERATOR

For use on Door #(s):

SB1001.A SB1004.A SB1021.A SB1051.A SB1058.A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 127X114MM		652	IVE
2	EA	DUMMY PUSH BAR	350 4'		626	VON
2	EA	90 DEG OFFSET PULL	8190EZHD 305MM STD		630-316	IVE
1	EA	OH STOP	100S		630	GLY
1	EA	OH STOP	100S ADJ		630	GLY
			USE WITH 4642L OPERATOR			
1	EA	SURFACE CLOSER	TJ4040XP LONG		689	LCN
1	EA	SURF. AUTO OPERATOR	4642 LONG CS WMS 120 VAC		689	LCN
1	EA	TOP JAMB MTG PLATE	4040XP-18TJ		689	LCN
2	EA	ACTUATOR, TOUCH	8310-836T		630	LCN

Hardware Group No. 009

For use on Door #(s):

SB1002.A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 127X114MM		652	IVE
1	EA	PANIC HARDWARE	CDSI-3549A-L-03		626	VON
1	EA	PANIC HARDWARE	CDSI-3549A-L-DT-03		626	VON
3	EA	CONSTRUCTION KEYED MORTISE CYLINDER	64-42		626	SAR
3	EA	I/C CYLINDER	6300		626	SAR
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	TJ4040XP LONG		689	LCN
2	EA	TOP JAMB MTG PLATE	4040XP-18TJ		689	LCN
2	SET	MEETING STILE	328AA-S X DH		AA	ZER
1	SET	SOUND SEAL	770AA 2/DW X 2/DH		AA	ZER
2	EA	DOOR BOTTOM	361AA X DW		AA	ZER

**YUKON UNIVERSITY
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Hardware Group No. 010 - CARD READER

For use on Door #(s):
SB1005.A

Provide each UEP door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
5	EA	HINGE	5BB1HW 127X114MM		652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 127X114MM CON TW8	 ⚡	630	IVE
1	EA	CONST LATCHING BOLT	FB51P		630	IVE
1	EA	DUST PROOF STRIKE	DP1		626	IVE
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	ELECTRIC LOCK	64-82271-LNJ		⚡ 626	SAR
2	EA	SURFACE CLOSER	4040XP HEDA		689	LCN
2	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
2	EA	FLOOR STOP	FS439		682	IVE
2	EA	DPDT DOOR POSITION SWITCH	SD-84C		⚡ WHT	
1		CARD READER	WORK OF DIVISION 28			
1		POWER SUPPLY	WORK OF DIVISION 28			

Hardware Group No. 011

For use on Door #(s):
SB1006.A

Provide each UEP door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 127X114MM		652	IVE
1	EA	CONST LATCHING BOLT	FB51P		630	IVE
1	EA	DUST PROOF STRIKE	DP1		626	IVE
1	EA	MORTISE STOREROOM LOCK	64-8204 LNJ		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	COORDINATOR	COR X FL		US26D	IVE
2	EA	MOUNTING BRACKET	MB1 OR MB2		BLK	IVE
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	SET	GASKETING	8303AA-S X 1/DW X 2/DH		AA	ZER
1	EA	ASTRAGAL	43SP X DH		SP	ZER

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Hardware Group No. 012 - CARD READER LOCK

For use on Door #(s):

SB1007.A	SB1008.A	SB1012.A	SB1016.A	SB1017.A	SB1018.A
SB1019.A	SB1022.A	SB1022.B	SB1025.A	SB1032.B	SB1035.A
SB1036.A	SB1037.A	SB1038.A	SB1040.A	SB1044.A	SB1045.A
SB1049.A	SB1053.A	SB1054.B	SB1057.A		

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 127X114MM		652	IVE
1	EA	CREDENTIAL READER MORTISE LOCK	64-IN100-82271-BIPS-B-LNJ		↗ 626	SAR
1	EA	SGL CYL DEADBOLT	B660P EV29 S		626	SCH
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS439		682	IVE

Hardware Group No. 013

For use on Door #(s):

SB1009.A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 127X114MM		652	IVE
1	EA	CREDENTIAL READER MORTISE LOCK	64-IN100-82271-BIPS-B-LNJ		↗ 626	SAR
1	EA	SGL CYL DEADBOLT	B660P EV29 S		626	SCH
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	SET	GASKETING	8303AA-S X 1/DW X 2/DH		AA	ZER
1	EA	DOOR BOTTOM	361AA X DW		AA	ZER

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Hardware Group No. 014

For use on Door #(s):

SB1013.A	SB1013.B	SB1015.A	SB1015.B	SB1015.C	SB1052.A
SB1052.B	SB1052.C	SB1052.D	SB1052.E	SB1052.G	SB1055.A
SB1056.A					

Provide each DA door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	PIVOT SET	7255 SET		626	IVE
1	EA	MORTISE LOCK	64-8257 LNJ V20		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	DOUBLE LIP STRIKE C/W KEYED STOP	ADL-CEK-HD CUSTOM 2 3/4" TALL -SARGENT 8257 X JAMB DEPTH		630	ACC
1	EA	OH STOP	100S		630	GLY
2	EA	KICK PLATE	8400 255MM X 25MM LDW B-CS		630	IVE
1	EA	MEETING STILE	398V X DH		AL	ZER

Hardware Group No. 015

For use on Door #(s):

SB1013.C	SB1013.D	SB1015.D	SB1052.F
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Provide each DA door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
1	EA	PIVOT SET	7255 SET		626	IVE
1	EA	MORTISE LOCK	64-8257 LNJ V20		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	DOUBLE LIP STRIKE C/W KEYED STOP	ADL-CEK-HD CUSTOM 2 3/4" TALL -SARGENT 8257 X JAMB DEPTH		630	ACC
2	EA	KICK PLATE	8400 255MM X 25MM LDW B-CS		630	IVE
2	EA	WALL STOP	WS401/402CCV		626	IVE
1	EA	MEETING STILE	398V X DH		AL	ZER

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Hardware Group No. 016

For use on Door #(s):

SB1014.A SB1043.A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 127X114MM		652	IVE
1	EA	MORTISE STOREROOM LOCK	64-8204 LNJ		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	EA	SEAL SET	188SBK X 1/DW X 2/DH		BLK	ZER

Hardware Group No. 017 - CARD READER LOCK

For use on Door #(s):

SB1023.A SB1032.A SB1032.C SB1054.A

Provide each UEP door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 127X114MM		652	IVE
1	EA	CONST LATCHING BOLT	FB51P		630	IVE
1	EA	DUST PROOF STRIKE	DP1		626	IVE
1	EA	CREDENTIAL READER MORTISE LOCK	64-IN100-82271-BIPS-B-LNJ		626	SAR
1	EA	SGL CYL DEADBOLT	B660P EV29 S		626	SCH
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	SURFACE CLOSER	4040XP HEDA		689	LCN
2	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS439		682	IVE

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Hardware Group No. 018

For use on Door #(s):
SB1024.A

Provide each UEP door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 127X114MM		652	IVE
1	EA	CONST LATCHING BOLT	FB51P		630	IVE
1	EA	DUST PROOF STRIKE	DP1		626	IVE
1	EA	CREDENTIAL READER MORTISE LOCK	64-IN100-82271-BIPS-B-LNJ		↗ 626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
2	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	EA	FLOOR STOP	FS439		682	IVE

Hardware Group No. 019 - CARD READER LOCK

For use on Door #(s):
SB1026.A SB1026.B SB1026.C

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 127X114MM		652	IVE
1	EA	CREDENTIAL READER MORTISE LOCK	64-IN100-82271-BIPS-B-LNJ		↗ 626	SAR
1	EA	SGL CYL DEADBOLT	B660P EV29 S		626	SCH
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	OH STOP	100S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA		689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	SET	GASKETING	8303AA-S X 1/DW X 2/DH		AA	ZER
1	EA	DOOR BOTTOM	361AA X DW		AA	ZER

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Hardware Group No. 020

For use on Door #(s):

SB1028.A SB1029.A SB1030.A

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1 127X114MM		652	IVE
1	EA	CONST LATCHING BOLT	FB51P		630	IVE
1	EA	DUST PROOF STRIKE	DP1		626	IVE
1	EA	MORTISE STOREROOM LOCK	64-8204 LNJ		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	COORDINATOR	COR X FL		US26D	IVE
2	EA	MOUNTING BRACKET	MB1 OR MB2		BLK	IVE
2	EA	OH STOP	100S		630	GLY
2	EA	SURFACE CLOSER	4040XP EDA		689	LCN
2	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	SET	GASKETING	8303AA-S X 1/DW X 2/DH		AA	ZER
1	EA	ASTRAGAL	43SP X DH		SP	ZER

Hardware Group No. 021

For use on Door #(s):

SB1030.B

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 127X114MM		652	IVE
1	EA	MORTISE STOREROOM LOCK	64-8204 LNJ		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE

Hardware Group No. 022

For use on Door #(s):

SB1031.A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 127X114MM		652	IVE
1	EA	MORTISE STOREROOM LOCK	64-8204 LNJ		626	SAR
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	SURFACE CLOSER	4040XP SCUSH		689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE
1	SET	GASKETING	8303AA-S X 1/DW X 2/DH		AA	ZER

**YUKON UNIVERSITY
POLARIS PROJECT**

Hardware Group No. 023

For use on Door #(s):

SB1034.A SB1039.A SB1041.A

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 127X114MM		652	IVE
1	EA	CREDENTIAL READER MORTISE LOCK	64-IN100-82271-BIPS-B-LNJ		626	SAR
1	EA	SGL CYL DEADBOLT	B660P EV29 S		626	SCH
1	EA	I/C CYLINDER	6300		626	SAR
1	EA	OH STOP	100S		630	GLY
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS		630	IVE

1 GENERAL

1.1 Summary

- .1 Provide Glazing in accordance with requirements of Contract Documents.

1.2 References

- .1 American National Standards Institute (ANSI):
 - .1 ANSI Z97.1, Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test
- .2 ASTM International (ASTM):
 - .1 ASTM C1036, Standard Specification for Flat Glass
 - .2 ASTM C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
 - .3 ASTM C1172, Standard Specification for Laminated Architectural Flat Glass.
 - .4 ASTM C1349, Standard Specification for Architectural Flat Glass Clad Polycarbonate
 - .5 ASTM C1503, Standard Specification for Silvered Flat Glass Mirror.
 - .6 ASTM E330/E330M, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
 - .7 ASTM F1233, Standard Test Method for Security Glazing Materials And Systems
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 12.1, Safety Glazing.
 - .2 CAN/CGSB 12.3, Clear Float Glass.
 - .3 CAN/CGSB 12.4, Heat Absorbing Glass
 - .4 CAN/CGSB 12.6, Transparent (One-Way) Mirrors (withdrawn)
 - .5 CAN/CGSB 12.8, Insulating Glass Units.
 - .6 CAN/CGSB 12.9, Spandrel Glass. (withdrawn)
 - .7 CAN/CGSB 12.10, Glass, Light and Heat Reflecting (withdrawn)
 - .8 CAN/CGSB 12.11, Wired Safety Glass (withdrawn)
 - .9 CAN/CGSB 12.13, Patterned Glass. (withdrawn)
 - .10 CAN/CGSB 12.20, Structural Design of Glass for Buildings (withdrawn)
 - .11 CAN/CGSB 19.2, Glazing Compound, Nonhardening, Modified Oil Type (withdrawn)
 - .12 CAN/CGSB 19.13, Sealing Compound, One-Component, Elastomeric, Chemical Curing (withdrawn).
- .4 Glazing Association of North America (GANA): "GANA Glazing Manual".
- .5 Insulating Glass Manufacturers Alliance (IGMA):
 - .1 IGMA TB-3001, "Guidelines for Sloped Glazing."
 - .2 SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- .6 National Fire Protection Association (NFPA):
 - .1 NFPA 80, Standard for Fire Doors and Other Opening Protectives

1.3 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
 - .1 Furnish technical data describing the quality and performance of each material component or system to be used in the Work, e.g., the acoustical rating, "U" value, shading coefficient, glass Design Factor (D.F.) or other such primary characteristics as required by the Drawings or Specifications.
 - .2 Samples: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for color and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Furnish samples of the following.
 - .1 Sealed Glass Units: Submit one fully double glazed 300 mm x 300 mm sample; indicate which surface low-e coatings have been applied to; attach glass performance requirements to back side of unit.

1.4 Quality Assurance

- .1 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Installer: Use installers having experience with projects of similar scope and complexity, and approved for installing products by glass manufacturer.
 - .2 Delegated Design Professional: Manufacturer's engineering recommendations:
 - .1 Perform glazing work in accordance with written recommendations from the glass manufacturer or glass fabricator.
 - .2 Certify glass compatibility with glazing materials; such as insulating glass sealants, structural sealants and silicones, gaskets, setting blocks, and similar components
 - .3 Verify glass design, heat treatment and thickness; analyze for thermal stress and maximum deflection.
 - .2 Certifications: Provide the following during the course of the Work:
 - .1 Compliance Certification: Provide certificates from manufacturer indicating tested performance requirements required by Authorities Having Jurisdiction and these specifications have been met.

1.5 Delivery, Storage and Handling

- .1 Delivery and Acceptance Requirements: Deliver packaged materials in their original containers with manufacturer's labels and seals intact.
- .2 Storage and Handling Requirements: Store vertically, blocked off the floor in a weatherproof enclosure in original containers with manufacturers labels and seals intact until read for installation, and as follows:
 - .1 Install glass as soon as possible after delivery to site.
 - .2 Handle glass carefully to its place of installation.
 - .3 Prevent damage to glass, adjacent materials and surfaces.

1.6 Project/Site Conditions

- .1 Ambient Conditions: Maintain temperature, humidity and solar exposure conditions of glass and glazing materials during shipping, storage and site installation as required by manufacturer to maintain warranty and performance of installed products.

1.7 Warranty

- .1 Provide manufacturer's warranty for the following types of glass listed, against defects in materials and workmanship for the period indicated, commencing from the date of Substantial Performance of Work for minimum 10 years:

- .1 Seal Failure: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions.
- .2 Evidence of Failure: Obstruction of vision by dust, moisture, or film on interior surfaces of glass.
- .3 Allowable Specific Exclusions: Breakage resulting from thermal stress will be accepted as a limitation to the warranty in accordance with CAN/CGSB 12.20

2. PRODUCTS

2.1 Manufacturers

- .1 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 Vision Glass:
 - .1 AGC Flat Glass North America (formerly AFG or AFGD)
 - .2 AHC Glass (formerly Visteon)
 - .3 Guardian Industries
 - .4 Pilkington Glass of Canada
 - .5 Prelco Inc.
 - .6 Schott Glass AG
 - .7 Viracon Inc.
 - .8 Vitro Architectural Glass (PPG Industries)

2.2 Performance Requirements

- .1 Limit glass deflection to 1/200 with full recovery glazing materials.

2.3 Glass Materials

- .1 Float Glass: In accordance with CAN/CGSB-12.3, glazing quality and as follows:
 - .1 Clear Glass: tint to match existing
 - .2 Clear Tempered Glass: to CAN/CGSB-12.1 and as follows:
 - .1 Type: 2 - Tempered.
 - .2 Class: A - Annealed.
 - .3 Category: II - 540 J impact resistance.
 - .3 Tinted Glass: Manufactured in accordance with CAN/CGSB-12.4 and as follows:
 - .1 Glass Quality: Float glass, glazing quality.
 - .2 Type:
 - .1 Single Pane Applications: Type 1.
 - .2 Insulating Glass Applications: Type 2.
 - .3 Class: Class C - Tempered as required to prevent thermal shock breakage.
 - .4 Tint: grey
 - .4 Low Emissivity (Low E) Glass: In accordance with CAN/CGSB-12.10 and as having the following nominal properties:
 - .1 Glass Quality: Float glass, glazing quality, heat strengthened or tempered as required to prevent glass breakage arising from thermal shock.
 - .2 Tint: grey glass, having the following similar nominal monolithic properties:
 - .1 Thickness: 6 mm or greater as required to meet structural performance criteria
 - .2 NFRC (whole window) U-value Winter 0.15
 - .3 Solar Heat Gain Coefficient (SHGC): 0.40
 - .3 Basis-of-Design Materials: to meet requirements listed in Section 07 02 00

- .5 Thermal Transmission Coefficient: per ASTM C236-87/AAMA 1503.1; U-Value = 0.90 W/m²K (0.16 Btu/ft²F) for overall system (glazing unit plus frame).
- .6 Sound transmission loss characteristic as measured by ASTM E90: 36-44.
- .7 Mirrors, Silvered: to ASTM C1503 and as follows:
 - .1 Type: 1B - Float glass for high humidity use.
 - .2 Tint: Clear
 - .3 Edges: Pencil polished edge. Seal edges to prevent chemical or atmospheric penetration of backing.

2.4 Insulating Glass

- .1 Insulating Glass Units: Provide sealed insulating glass units in accordance with CAN/CGSB-12.8 in configurations indicated, and as specified herein.
 - .1 Manufacture sealed insulating glass units without edge channels or tape, that is, with bare glass edges.
 - .2 Use two stage seal method of manufacture, as follows:
 - .1 Primary Seal: polyisobutylene sealing compound between glass and metal spacer/separator.
 - .2 Secondary Seal: polyurethane, silicone or polysulphide base sealant, filling gap between the two lites of glass at the edge up to the spacer/separator and primary seal.
 - .3 Install stainless steel capillary breather tubes to equalize pressure differentials between insulating glass fabricating location and insulating glass installation location; crimp tube immediately prior to installation in accordance with glass fabricator's written instructions.
 - .4 Spacer/separator to provide continuous vapour barrier between interior of sealed unit and secondary seal.
- .2 Insulating Glass Units:
 - .1 Double Unit Composition - Doors:
 - .1 Exterior Lite: Clear tempered glass, having Low E coating on #2 surface.
 - .2 Air Space: 13 mm 90% Argon Filled
 - .3 Interior Lite: clear tempered
 - .2 Triple Unit Composition - Windows:
 - .1 Exterior Lite: grey tinted tempered glass, having Low E coating on #2 surface.
 - .2 Air Space: 13 mm 90% Argon Filled
 - .3 Intermediate Lite: clear annealed
 - .4 Air Space: 13 mm 90% Argon Filled
 - .5 Interior Lite: clear tempered with lowE coating on #5

2.5 Accessory Materials

- .1 Sealants: Silicone, one component - clear, with primers, sealers, cleaners all as specified in Section 07 92 00.
- .2 Glazing Tape: 100% polybutalene vehicle. Extruded in ribbon form with paper separator. Tape shall have an integral shim strip where required.
- .3 Setting Blocks: Silicone, Shore A Hardness 90; Shims Shore A Hardness 50.
- .4 Spacers: Silicone and other resilient blocks of 40 to 50 Shore A durometer hardness, adhesive-backed on one face only, tested for compatibility with specified primary and secondary glazing materials.
- .5 Mirror Clips: – C26 (polished chrome) finished steel, or stainless steel edge clips, with fastening concealed behind mirror.

- .6 Glazing Compound: For glazing to metal, in accordance with CAN/CGSB 19.2.
- .7 Cleaners, Primers, and Sealers: Type recommended by manufacturer of glass and gaskets.

2.6 Fabrication - General

- .1 Fabricate mirrors to fit measurements of finished spaces, made at the site. Use one piece for mirrors 1220 mm or less in width. Make no horizontal joints except where indicated.
- .2 Cut all glass to field measurement with proper clearances. Cut to produce clean, straight edges with no chips, cracks or flaws.
- .3 Make any cut outs, openings to approved drawings. Grind exposed edges smooth round off corners.

3. EXECUTION

3.1 Examination

- .1 Verify that openings for glazing are correctly sized and within tolerance.
- .2 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

3.2 Preparation

- .1 Ensure all glazing rebates smooth and true, free of projections nails, screws, fastenings properly set to prevent contact with glass.
- .2 Ensure all stops, splines, glazing accessories provided by others accurately cut to length and proper size and type for specific glazing.
- .3 Clean contact surfaces with solvent and wipe dry.
- .4 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .5 Prime surfaces scheduled to receive sealant.

3.3 Installation - General

- .1 Install in accordance with the manufacturer's written instructions and the contract documents, plumb, true, level and rigid.
- .2 Do not glaze when ambient or surface temperatures are less than 4°C. Glazing rebates, stops and glass shall be dry, free from ice, frost slick, grease, oil, dust, rust, or other matter detrimental to adhesion of tape, glazing compounds and sealant.
- .3 Installation of glass shall be by workmen skilled in this trade in strict accordance with manufacturer's directions, to produce a first class installation.
- .4 Position sealed units to provide minimum 12 mm glass bite, and minimum 6 mm perimeter clearance between glass and framing.
- .5 Glass shall be free from contact with the frames and stops.
- .6 Label each light to show manufacturer's name or trade mark, quality and thickness.
- .7 Glaze interior doors with foam or cork tape on both sides. – For wired glass, use glazing tape. – Trim tape even with the sight line.
- .8 Use sealant at exterior doors, sealing water and weather tight.
- .9 Install ticket window pass through in accordance with manufacturer's written recommendations.

- .10 Frameless glazing to have minimum 10 mm (3/8") wide vertical joints filled with clear silicone.
- 3.4 Installation - Mirrors
 - .1 Secure mirrors with a minimum of 4 clips per piece. – Provide pads to prevent direct metal-to-glass contact of clips or screws.
 - .2 Secure mirrors with a minimum of 4 clips per piece. – Provide pads to prevent direct metal-to-glass contact of clips or screws. Large Format Mirrors: provide minimum 8 clips per piece, clips anchored to concrete block, provide adequate support for large format mirrors.
 - .3 Align mirrors (in multiple application) to a parallel and true plane surface to produce a true reflection across all sections.
 - .4 Place plumb and level.
- 3.5 Glass Schedule
 - .1 Glass types as indicated on drawings.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide glazing films in accordance with requirements of the Contract Documents.
- .2 Indicated as GF in Section 09 06 06.

1.2 Administrative Requirements

- .1 Coordination: Coordinate the Work of this Section with the installation of glazing; sequence work so that installation of glazing films coincides with installation of glass materials without causing delay to the Work.
- .2 Pre-Installation Conference: Conduct on site pre-installation conference before installing glazing films and in conjunction with installation of mock-up attended by Contractor, Consultant, Owner, glazing film Installer and glazing film manufacturer's representative to:
 - .1 Review methods and procedures related to installation, including manufacturer's written instructions
 - .2 Examine substrate conditions for compliance with manufacturers installation requirements
 - .3 Review temporary protection measures required during and after installation.

1.3 Submittals

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
 - .1 Verification Samples: Submit 300 mm x 300 mm sample of each type of film to the Consultant.

1.4 Project Closeout Submissions

- .1 Operation and Maintenance Data: Submit manufacturer's written instructions for cleaning solutions, materials and procedures, include name of original installer and contact information.

1.5 Quality Assurance

- .1 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Installer: Use installers having documented experience with projects of similar extent and complexity and that have experience laminating film to glass on site.

1.6 Delivery, Storage and Handling

- .1 Delivery and Acceptance Requirements: Deliver and store packaged materials in their original containers with manufacturer's labels and seals intact; store as recommended by manufacturer in a weatherproof enclosure.

1.7 Site Conditions

- .1 Ambient Conditions: Proceed with film installation when ambient and substrate temperature conditions are within limits permitted by manufacturer and when glass substrates are free from wetness arising from frost, condensation, or other causes detrimental to adhesion.

2. PRODUCTS

2.1 Glazing Films

- .1 Translucent Glazing Film: Frosted etch vinyl film, adhered to outside face of glass, computer generated and cut:

- .1 Acceptable manufacturers:
 - .1 Aztech
 - .2 Protint
 - .3 Sparcal
 - .4 3M
 - .5 Llumar
- .2 Refer to Section 09 06 06 for GF-1 to GF-3.

3. EXECUTION

3.1 Examination

- .1 Examine glass and surrounding adjacent surfaces for conditions affecting installation; proceed with installation after verification and correction of surface conditions acceptable to manufacturer.

3.2 Preparation

- .1 Prepare glazing films using computer generated CNC cutting methods to eliminate any cutting of films directly on glass at project site.
- .2 Clean glass surfaces of substances that could impair glazing film bond including mould, mildew, oil, grease, dirt and other foreign materials immediately before beginning installation of films.
- .3 Protect window frames and surrounding conditions from damage during installation.

3.3 Installation

- .1 Install in accordance with the manufacturer's written instructions and the contract documents, plumb, true, and level over clean glazing.
- .2 Install film continuously, but not necessarily in one continuous length, with no gaps or overlaps and as follows:
 - .1 Install seams vertical and plumb where necessary; horizontal seams will not be allowed.
 - .2 Do not remove release liner from film until just before each piece of film is cut and ready for installation.
 - .3 Install film with mounting solution and custom cut to the glass with neat, square comers and edges to within 3 mm of window frame.
 - .4 Remove air bubbles, wrinkles, blisters, and other defects.
- .3 Installation Tolerances: Consultant will view film installation from a distance of 3 metres against a bright uniform sky or background and will accept installation where it appears uniform in appearance with no visible streaks, banding, thin spots or pinholes; remove and replace with new film when directed by the Consultant for materials not meeting requirements.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 General: Provide Louvres and Vents in accordance with requirements of the Contract Documents.
- .2 This Section includes louvres that form a part of architectural building finishes and includes, but is not limited to, the following:
 - .1 Fixed, extruded aluminum louvres.

1.2 References

- .1 Air Movement and Control Association International Inc. (AMCA):
 - .1 AMCA 500-L, Laboratory Methods of Testing Louvres for Rating.
 - .2 AMCA 501, Application Manual for Air Louvres.
- .2 NAAMM, Metal Finishes Manual for Architectural and Metal Products.
- .3 SMACNA's Architectural Sheet Metal Manual.

1.3 Definitions

- .1 **Louvre Terminology:** Definitions of terms for metal louvres contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

1.4 Performance Requirements

- .1 Provide louvres that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and night time sky heat loss:
 - .1 Winter Minimum: Ambient -40°C, Surface -35°C.
 - .2 Summer Maximum: Ambient +35°C, Surface +50°C.
 - .3 Temperature Range: Ambient 75°C, Surface 85°C difference.
- .2 Provide louvres having air performance, water penetration, air leakage, and wind driven rain ratings in accordance with performance requirements listed in this Section and as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.

1.5 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
 - .1 Furnish technical data describing the quality and performance of each material component or system to be used in the Work, e.g., the louver air performance and water penetration ratings or other such primary characteristics as required by the Drawings or Specifications.
- .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings for the fabrication and installation of the Work. Prepare details at not less than 1:5 minimum scale. Show typical details of the conditions for every member, joint, anchorage and support in the system.

- .3 Samples: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for color and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Furnish samples on the actual metal required for the Work, not less than 300 mm lengths of extrusion or 300 mm squares of sheet, showing maximum range or variation in color and shade, and match the Consultant's sample.
- .4 Closeout Submittals: Submit for Owner's documentation.
- .1 Warranty.
- 1.6 Quality Assurance
- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- .2 Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of National, Provincial and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.
- .3 Obtain louvres and vents from a single source and manufacturer they are of same type, design, or factory applied colour finish.
- .4 Perform welding for structural quality joins using procedures and personnel having certifications specific to the work of this Section in accordance with CSA W47.2 and W59.2.
- .5 Construct flashings in accordance with recommendations in SMACNA Architectural Sheet Metal Manual for fabrication, construction details, and installation procedures.
- .6 Follow NAAMM's recommendations for applying and designating finishes; finish louvres after assembly.
- 1.7 Delivery, Storage and Handling
- .1 General: Deliver and store materials in manufacturer's original packaging with labels to show name, brand, type, and grade. Store materials in protected dry location off ground in accordance with manufacturer's instructions. Do not open packaging nor remove labels until time for installation.
- .2 Removable Protective Coverings: Provide finished panels and accessories with manufacturer's recommended temporary protective covering. Maintain covering on materials until installation. Covering shall not to affect factory finish coating nor leave residue or other deleterious matter on surface.
- 1.8 Project/Site Conditions
- .1 Field Measurements: Verify dimensions of supporting structure at the project site by accurate field measurements so that louvers are accurately designed, fabricated and fitted to the structure. Tolerances for supporting structure are specified in other Sections. Notify Contractor in writing, of any dimensions found to be different than shown, including specified tolerances. Use Contractor's bench marks as basis of measurements.
- 1.9 Warranty
- .1 Factory Finish Warranty: Submit for Owner's documentation. Furnish manufacturer's 5 year written warranty, warranting that the factory-applied finishes will not develop excessive fading or excessive non-uniformity of colour or shade, and will not crack, peel, pit, corrode, or otherwise fail as a result of defects in materials or workmanship within the following defined limits. Upon notification of such defects, within the warranty period, make necessary repairs or replacement at the convenience of the Owner.

- .1 "Excessive Fading": A change in appearance which is perceptible and objectionable as determined by the Consultant when visually compared with the original color range standards.
- .2 "Excessive Non-Uniformity": Non-uniform fading during the warranty period to the extent that adjacent panels have a colour difference greater than the original acceptable range of color.
- .3 "Will Not Pit or Otherwise Corrode": No pitting or other type of corrosion, discernible from a distance of 3000 mm, resulting from the natural elements in the atmosphere at the project site.

2. PRODUCTS

2.1 Performance

- .1 Provide louvres having air performance, water penetration, air leakage, and wind driven rain ratings in accordance with performance requirements listed in this Section and as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.
- .2 Provide acoustical louvres in accordance with airborne sound transmission loss ratings indicated, as demonstrated by testing manufacturer's stock units identical to those specified, except for length and width in accordance with ASTM E90.

2.2 Manufacturers

- .1 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 Airolite Company LLC
 - .2 Construction Specialties Company
 - .3 Greenheck Fan Corporation
 - .4 Nystrom Airline Products Co.
 - .5 Ten Plus Louvres
 - .6 Ventext
 - .7 Skyline

2.3 Materials

- .1 Aluminum Extrusions: ASTM B221M, alloy 6063-T5 or T-52.
- .2 Aluminum Sheet: ASTM B209M, alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- .3 Aluminum Castings: ASTM B26M, alloy 319.
- .4 Fasteners: Provide fasteners of same basic metal and alloy as fastened metal or 300 Series stainless steel; use only metals that are incompatible with joined materials, and as follows:
 - .1 Use types and sizes to suit unit installation conditions.
 - .2 Use Phillips flat head screws for exposed fasteners.
- .5 Bituminous Paint: Cold applied asphalt emulsion in accordance with ASTM D1187.

2.4 Fixed, Extruded Aluminum Louvres

- .1 Vertical, Drainable Blade Louvre:
 - .1 Louvre Depth: Nominal 100 mm.
 - .2 Frame and Blade Thickness: Manufacturer's standard for blades and frames to suit structural requirements, with integral mounting frame coordinated with adjacent construction.

2.5 Louvre Screens

- .1 Provide screen at each exterior louvre, and as follows:
 - .1 Screen Location for Fixed Louvres: Interior face.
 - .2 Screening Type: Bird screening.
- .2 Secure screens to louvre frames with stainless-steel machine screws, spaced a maximum of 150 mm from each corner and at 300 mm O/c.
- .3 Louvre Screen Frames: Fabricate with mitred corners to suit louvre sizes, and as follows:
 - .1 Material: Same kind and form of metal as indicated for louvre that screens are attached; reinforce extruded-aluminum screen frames at corners with clips.
 - .2 Finish: Same finish as louvre frames that louvre screens are attached].
 - .3 Type: Rewirable frames with a driven spline or insert for securing screen mesh.
- .4 Louvre Screening:
 - .1 Bird Screening: Manufacturer's standard aluminum, nominal 13 mm square mesh using 1.0 mm diameter wire.

2.6 Fabrication

- .1 Assemble louvres in factory to minimize field splicing and assembly.
- .2 Disassemble units as necessary for shipping and handling limitations.
- .3 Clearly mark units for reassembly and coordinated installation.
- .4 Fabricate vertical assemblies to permit field bolted assembly with close fitting, reinforced joints in jambs and mullions where height of louvre units exceeds fabrication and handling limitations, and as follows:
 - .1 Continuous Vertical Assemblies: Fabricate units without interrupting blade spacing pattern unless horizontal mullions are indicated.
- .5 Maintain equal louvre blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- .6 Fabricate frames; including integral sills, to fit in openings with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- .7 Include supports, anchorages, and accessories required for complete assembly.
- .8 Provide vertical mullions of type and at spacing indicated, but not more than recommended by manufacturer, 1800 mm O/c, whichever is less, and as follows:
 - .1 Exposed Mullions:
 - .1 Provide units with exposed mullions of same width and depth as louvre frame.
 - .2 Provide interlocking split mullions designed to permit expansion and contraction where length of louvre exceeds fabrication and handling limitations.
- .9 Exterior Corners: Prefabricated corner units with mitred and welded blades and with semi-recessed mullions at corners.
- .10 Provide sub-sills made of same material as louvres or extended sills for recessed louvres.
- .11 Join frame members to each other and to fixed louvre blades with fillet welds concealed from view or size of louvre assembly makes bolted connections between frame members necessary.

2.7 Aluminum Finishes

- .1 Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- .2 High Performance Organic Finish:
 - .1 3 Coat PVDF Coating: AA-C12 Chemical Finish, cleaned with inhibited chemicals; C40 Chemical Finish, conversion coating; R1x Organic Coating, manufacturer's standard 3 coat, thermo-cured system consisting of specially formulated inhibitive primer, fluoropolymer colour coat, and clear fluoropolymer topcoat, with both colour coat and clear topcoat containing not less than 70% PVDF resin by weight; prepare, pre-treat, and apply coating to exposed metal surfaces in accordance with AAMA 2605 and with coating and resin manufacturers' written instructions.
 - .2 Colour: As selected by Consultant from manufacturer's full range.
 - .3 Basis-of-Design Materials: PPG Duranar XL

3. EXECUTION

3.1 Examination

- .1 Examine substrates and openings and verify requirements for installation tolerances and other conditions affecting performance.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

- .1 Locate and place louvres level and plumb at indicated alignment with adjacent work.
- .2 Use concealed anchorages where possible; provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.
- .3 Form closely fitted joints with exposed connections accurately located and secured.
- .4 Provide perimeter reveals and openings of uniform width for sealants and joint fillers.
- .5 Repair finishes damaged by cutting, welding, soldering, and grinding, and as follows:
 - .1 Restore finishes so no evidence remains of corrective work.
 - .2 Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- .6 Protect galvanized and nonferrous metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces.
- .7 Install concealed gaskets, flashings, joint fillers, and insulation as louvre installation progresses where weather tight louvre joints are required, refer to Section 07 92 00 for sealants applied during louvre installation.

3.3 Adjusting and Cleaning

- .1 Clean exposed surfaces of louvres that are not protected by temporary covering, to remove fingerprints and soil during construction period; do not let soil accumulate until final cleaning.
- .2 Clean exposed surfaces with water and a mild soap or detergent not harmful to finishes, and thoroughly rinse surfaces and dry before final inspection.

- .3 Restore louvres damaged during installation and construction so no evidence remains of corrective work; remove damaged units and replace with new units where results of restoration are unsuccessful, as determined by Consultant.
- .4 Touch up minor abrasions in finishes with compatible air dried coating matching colour and gloss of factory applied finish coating.

END OF SECTION

Interior Finishes

- .1 Basis-of-Design: Materials and colours listed form the Basis-of-Design materials for this project.
- .2 Materials other than named products Basis-of-Design materials may be acceptable to the Consultant; submit Product Options information no later than seven (7) days prior to bid closing date and as follows:
 - .1 Proposed alternates shall match colour range, texture and performance characteristics of named products, and shall not require a change to colour board for Project.
 - .2 Proposed alternates found acceptable by Consultant will be listed in an Addendum.
 - .3 The Consultant is not obliged to accept any materials presented for their review and does not need to provide reasons for rejection of proposed alternates.

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
Flooring			
RSF-1	Resilient Sheet Flooring Wet Labs - Field	Manufacturer: Tarkett Series: iQ Optima Pattern and Color: 205 Summer Moon W Additional information: 2.0mm Base: Coved 100mm High	09 65 00
RSF-2	Resilient Sheet Flooring Wet Labs- Winter Accent Blue	Manufacturer: Tarkett Series: iQ Optima Pattern and Color: 849 Blue Satin Additional information: 2.0mm Base: Coved 100mm High	09 65 00
RSF-3	Resilient Sheet Flooring Wet Labs- Winter Accent Blue	Manufacturer: Tarkett Series: iQ Optima Pattern and Color: 250 Rushing Waters Additional information: 2.0mm Base: Coved 100mm High	09 65 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
RSF-4	Resilient Sheet Flooring-Static Resistant	Manufacturer: Tarkett Series: IQ Granite SD Style: 950 Black Grey Additional information: 2.0mm Base: RB-1	09 65 00
RSF-5	Resilient Sheet Flooring Wet Labs – Fall Accent Green	Manufacturer: Tarkett Series: iQ Optima Pattern and Color: 253 Greenhouse Lane Additional information: 2.0mm Base: Coved 100mm High	09 65 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
RSF-6	Resilient Sheet Flooring Wet Labs – Fall Accent Green	Manufacturer: Tarkett Series: iQ Optima Pattern and Color: 252 Putting green Additional information: 2.0mm Base: Coved 100mm High	09 65 00
RSF-7	Resilient Sheet Flooring Location: Corridors, lounge/event space, & dry labs - Field	Manufacturer: TBD Series: Pattern and Color: Light Grey Additional Information: Base: Coved 100mm High	09 65 00
RSF-8	Resilient Sheet Flooring Location: Corridors, lounge/event space, & dry labs	Manufacturer: TBD Series: Pattern and Color: Medium Grey Base: Coved 100mm High	09 65 00
RSF-9	Resilient Sheet Flooring Location: Corridors, lounge/event space, & dry labs	Manufacturer: TBD Series: Pattern and Color: Dark Grey Additional Information: Base: Coved 100mm High	09 65 00
RSF-10	Resilient Sheet Flooring Location: Ceremonial Room	Manufacturer: TBD Series: Pattern and Color: Black Additional Information: Base: Coved 100mm High	09 65 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
RSF-11	Resilient Sheet Flooring Location: Ceremonial Room	Manufacturer: TBD Series: Pattern and Color: White Additional Information: Base: Coved 100mm High	09 65 00
RSF-12	Resilient Sheet Flooring Location: Ceremonial Room	Manufacturer: TBD Series: Pattern and Color: Red Additional Information: Base: Coved 100mm High	09 65 00
RSF-13	Resilient Sheet Flooring Location: Ceremonial Room	Manufacturer: TBD Series: Pattern and Color: Yellow Additional Information: Base: Coved 100mm High	09 65 00
RSF-14	Stair Covering & Stair Nosing	Manufacturer: Tarkett Series: Angle Fit Rubber Stair Tread with Integrated Riser Pattern and Color: 460 Cotton Finish: Hammered Profile: VIHT Safe-T-Rib Square Nose, Co-Extruded Vinyl Insert 47 Brown Rubber Stringer material to match RB-1	09 65 10
RSF-15	Stair Tactile Surface	Manufacturer: Tarkett Series: Tactile Warning Surface - Rubber Pattern and Color: 264 Grounded Finish: Tactile Warning	09 65 10

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
WM-1	Walk Off Mat	Manufacturer: Milliken Series: Obex Pattern: CutX Contour Color: Dark Grey CNX119 Additional Information: 4.72mm Thick Base: RB-1	12 48 13
WM-2	Walk Off Mat	Manufacturer: Milliken Series: Obex Pattern: CutX Contour Color: Grey CNC27 Additional Information: 4.72mm Thick Base: Coved Terrazo	12 48 13
EXP	N/A	Exposed Concrete	
Base			
RB-1	Rubber Base	Manufacturer: Tarkett Series: Baseworks Thermoset Rubber Color: 63 Burnt Umber B Size: 1/8" thick. x 4" high, with toe	09 65 00
Transitions			
TS-2	Resilient to Polished Concrete	Manufacturer: Johnsonite Profile: Slim Line Transitions Product: SLT-63-J Code: Burnt Umber 63	09 65 00
TS-3	Walk off to Resilient	Manufacturer: Johnsonite Profile: Reducer Product: CRS-63-D Color: Burnt Umber 63	09 65 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
Paint			
P-1	Paint White Field – Walls and Ceilings	Manufacturer: Benjamin Moore Color #: OC-21 Color Name: Winter White Wall finish: Gloss Level 3 for walls and Gloss Level 1 for ceilings	09 91 00
P-2	Mid Grey	Manufacturer: Sherwin Williams Color #: SW 9163 (236-C4) Color Name: Tin Lizzie Wall finish: Gloss Level 3	09 91 00
P-3	Black	Manufacturer: Sherwin Williams Color #: SW 7069 (251-C7) Color Name: Iron Ore Wall finish: Gloss Level 3	09 91 00
P-4	Spring Light Blue	Manufacturer: Sherwood Williams Color #: SW 6239 (224-C1) Color Name: Upward Wall finish: Gloss Level 3	09 91 00
P-5	Spring Dark Blue	Manufacturer: Sherwin Williams Color #: SW 6242 (224-C5) Color Name: Bracing Blue Wall finish: Gloss Level 3	09 91 00
P-6	Summer Light Blue	Manufacturer: Sherwin Williams Color #: SW 9054 (173-C1) Color Name: Little Boy Blu Wall finish: Gloss Level 3	09 91 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
P-7	Summer Dark Blue	Manufacturer: Sherwin Williams Color #: SW 9058 (173-C5) Color Name: Secret Cove Wall finish: Gloss Level 3	09 91 00
P-8	Fall Light Green	Manufacturer: Sherwin Williams Color #: SW 6190 (214-C1) Color Name: Filmy Green Wall finish: Gloss Level 3	09 91 00
P-9	Fall Dark Green	Manufacturer: Sherwin Williams Color #: SW 9129 (214-C4) Color Name: Jade Dragon Wall finish: Gloss Level 3	09 91 00
P-10	Winter Light Blue	Manufacturer: Sherwin Williams Color #: SW 6225 (220-C1) Color Name: Sleepy Blue Wall finish: Gloss Level 3	09 91 00
P-11	Winter Dark Blue	Manufacturer: Sherwin Williams Color #: SW 6228 (220-C5) Color Name: Refuge Wall finish: Gloss Level 3	09 91 00
Ceilings			
ACT-1	Acoustic Ceiling Tile Dry Lab and Classrooms High NRC .85/ CAC 35	Manufacturer: Armstrong Type: Ultima High NRC Type Number: 2083 Size: 610mm x 1220mm x 25mm plank Grid: Square Lay-In 15/16 in Suspension system: Prelude XL 15/16" Exposed Tee	09 51 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
ACT-2	Acoustic Ceiling Tile Wet Labs - Wipeable NRC .85/ 35 CAC	Manufacturer: CGC Type: Mars Healthcare High-NRC Acoustical Panel Type Number: 88256 Size: 610mm x 1220mm x 22mm plank Grid: Square Edge Suspension system: Donn Brand AX 15/16" Acoustical suspension System (Flat White 050) Accessories: Hold Down Clip L15/L15CE	09 51 00
ACT-3	Acoustic Ceiling Tile Wood Feature – Classrooms High NRC .60	Manufacturer: Armstrong Type: Woodworks Linear Veneered Planks Type Number: 6440W1 Size: 2438mm x 95mm x 95mm with 19mm reveal Colour: Quartered Walnut Bioacoustic infill panel-black Suspension system: Prelude XL 15/16" Exposed Tee; Heavy Duty Trim: Axiom Vector Curved Perimeter Trim AX6VECUR (for clouds) Trim: Curved wall molding/column ring AXM34CURBL (for trim @ gwb)	09 51 26

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
ACP-1	Acoustic Ceiling Panels Location: Lounge/Event Space 1.38 Sabins/SF	Manufacturer: Armstrong Type: Soundscape Blades Type Number: 3920 Size: 190mm x 1168mm x 50mm Colour: White Suspension system: Individual Suspension using hanging kit 6655	09 52 00
ACP-2	Acoustic Ceiling Panels Location: Lounge/Event Space 1.38 Sabins/SF	Manufacturer: Armstrong Type: Soundscape Blades Type Number: 3920 Size: 190mm x 1168mm x 50mm Colour: Black Suspension system: Individual Suspension using hanging kit 6655	09 52 00
ACP-3	Acoustic Ceiling Panels Location: Lounge/Event Space 1.38 Sabins/SF	Manufacturer: Armstrong Type: Soundscape Blades Type Number: 3920 Size: 190mm x 1168mm x 50mm Colour: Custom Red Suspension system: Individual Suspension using hanging kit 6655	09 52 00
ACP-4	Acoustic Ceiling Panels Location: Lounge/Event Space 1.38 Sabins/SF	Manufacturer: Armstrong Type: Soundscape Blades Type Number: 3920 Size: 190mm x 1168mm x 50mm Colour: Custom Yellow Suspension system: Individual Suspension using hanging kit 6655	09 52 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
ACP-5	Acoustic Ceiling Panels Location: Lecture Hall .75 NRC	Manufacturer: Acoufelt Type: Curve ½” Size: 254mm x 1220mm x 12mm Colour: Grey Suspension system: Cable to Deck	09 52 00
ACP-6	Acoustic Ceiling Panels Location: Corridors .75 NRC	Manufacturer: Turf Type: Freedom Ceiling Baffle Size: Depth 190mm Thickness 50mm Colour: 01 Cream Suspension system: Cable to Deck	09 52 00
Doors + Frames			
P-2	Metal Doors	Manufacturer: Sherwin Williams Color #: SW 9163 (236-C4) Color Name: Tin Lizzie Finish: Gloss Level 5	09 91 00
P-3	All Frames	Manufacturer: Sherwin Williams Color #: SW 7069 (251-C7) Color Name: Iron Ore finish: Gloss Level 5	09 91 00
PL-1	Wood Doors	Manufacturer: Wilsonart Basic Color #: 7938-38 335 Pattern and Color Name: New Age Oak Finish: 38 Fine Velvet Finish	06 40 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
Plastic Laminate			
PL-1	Plastic Laminate - Interior, Exterior and Door Cabinets	Manufacturer: Wilsonart Basic Color #: 7938-38 335 Pattern and Color Name: New Age Oak Finish: 38 Fine Velvet Finish	06 40 00 08 14 00
PL-2	Plastic Laminate – Interior Cabinets	Manufacturer: Wilsonart Basic Color #: D354 335 Pattern and Color Name: Designer White Finish: 60 Matte Finish	06 40 00
PL-3	Plastic Laminate – Reception desk	Manufacturer: Wilsonart Traceless Color #: 15505 Pattern and Color Name: Black Velvet Finish: 15505	06 40 00
Graphic Wall Vinyl			
GVF-1	Graphic Wall Vinyl Location: North wall of admin desk	Manufacturer: 3M Series: Scotchcal Graphic Film 3690-10 Pattern and Color: Digital Print- Black and White Mountains Image to be supplied by consultant	09 72 00
GVF-2	Graphic Wall Vinyl Location: Classroom Front Wall	Manufacturer: 3M Series: Scotchcal Graphic Film 3690-10 Pattern and Color: Digital Print Welcome Graphic Image to be supplied by consultant	09 72 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
GVF-3	Graphic Wall Vinyl Location: Alcove across from Research and Multi use Lab	Manufacturer: 3M Series: Scotchcal Graphic Film 3690-10 Pattern and Color: Digital Print - Triangles Image to be supplied by consultant	09 72 00
GVF-4	Graphic Wall Vinyl Location: Printing area	Manufacturer: 3M Series: Scotchcal Graphic Film 3690-10 Pattern and Color: Digital Print- Black and White Mountains Image to be supplied by consultant	09 72 00
Wallcovering			
WC-1	Wall Covering Sharing Knowledge Space	Manufacturer: Maharam Series: Showers by Alexander Girard Pattern and Color: 001 Emerald Light and Turquoise	09 72 00
Solid Surface			
SF-1	Solid Surface Composite Location: Countertops	Manufacturer: Corian Pattern and Color: Linen Finish: Semi Gloss Thickness: 12mm	06 61 16
SF-2	Solid Surface Composite Location: Washroom Sink	Manufacturer: Wilsonart Pattern and Color: Avalanche Mélange Finish: Semi Gloss Thickness: 12mm	06 61 16

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
SF-3	Solid Surface Composite Location: Window Sills	Manufacturer Corian Pattern and Color: Deep Storm Finish: Semi Gloss Thickness: 12mm	06 61 16
Wall Tile			
WT-1	Porcelain Tile Location: Washroom Field and Stall Walls	Manufacturer: Nasco Series: Bio-Crete Pattern and Color: Ivory Size: 305" x 610" Finish: Matte Thickness: 9.5mm Trim Edge: Schluter ECK-E, at outside corner edges only Grout: To match adjacent tile	09 30 00
WT-2	Porcelain Tile Location: Stall back wall	Manufacturer: Nasco Series: Pacifico Pattern and Color: Teal Finish: Matte Size: 200mm x 200mm Thickness: 9.5mm Trim Edge: Schluter ECK-E, at outside edges only Grout: To match adjacent tile	09 30 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
WT-3	Porcelain Tile Location: Feature Wall	Manufacturer: Ceratec Series: Terra Pattern and Color: Stella F Finish: Matte Size: 200mm x 200mm Thickness: 9mm Trim Edge: Schluter ECK-E, at outside corner edges only Grout: To match adjacent tile	09 30 00
Glazing Film			
GF-1-3	Window Film - Decorative Location: Sidelights and BL Interior Glazing	Manufacturer: 3M Series: TBD Opacity: 16% Light Reflectance, 63% Light Transmittance Surface Finish: Matte Pattern and Color: TBD Image to be supplied by consultant Location as noted on drawings.	08 87 00
Wall Protection and Wall Panels			
FRP-1	Fiber Reinforced Plastic Location: Janitor Room – Mop Sink Surround	Manufacturer: Panolam Pattern and Color: White Thickness: .090” Height: 1370mm AFF	10 26 23

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
WP-1	Thermoplastic Sheet Wall Protection Location: Back of House	Manufacturer: Acrovyn Color #: 949 Color Name: White Finish: Suede Texture Height to 1500mm AFF	10 26 23
WWP-1	Wall mounted wood planks NRC:	Manufacturer: Armstrong Type: Woodworks Linear Veneered Planks Type Number: Custom pattern Size: 2438mm x 95mm x 95mm with 19mm reveal Colour: Quartered Walnut	09 51 26
WWP-2	Wall mounted wood planks NRC: .60	Manufacturer: Odyssey Wallcovering Type: Acoustic Woodwerx - Online Size: 96" x 12.8" panel Colour: White Oak Matching moulding at all outer corners.	09 51 26
AWP-1	Acoustic Wall Panel NRC: .65	Manufacturer: Hush Acoustics Type: Shaped Wall Tile – Diamond Size: 300mm x 520mm panels Thickness: 9mm Edge: Straight Colour: Vanilla Note: cut to suite patterns	09 84 00

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
Millwork			
WD-1	Wood Slats	Wood Species: White Oak Product: Solid Lumber Dimensions: 50mm x 12mm Grade: II (pieces shall be well-matched for colour and grain) Stain: To match WWP-2 Finish: Sanded smooth, sealed to maintain colour, and finished with a water-based clear coat: Sansin water-based clear top coat. Note: Millworker to provide finish sample to designer prior to fabrication.	06 40 00
Corner Guards			
CG-1	Stainless Steel Corner Guard	Manufacturer: Pawling Style: CG-50 Size: 90mm Radius: Standard Finish: Satin Finish From top of base to 1370mm	10 26 23
CG-2	Stainless Steel Corner Guard	Manufacturer: Pawling Style: CG-50 Size: 90mm Radius: Standard Finish: Satin Finish From top of base to 2200mm	10 26 23

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
Specialty Items			
LK-1	Lockers - Corridors	Manufacturer: Shanahan's Type: Deluxe ST Size: as indicated on drawings Color: Body: 908 Black, Doors: 201 Gray	10 51 13
LK-2	Lockers Accessible – Corridors	Manufacturer: Shanahan's Type: Deluxe ST Size: as indicated on drawings Color: Body: 908 Black, Doors: 201 Gray	10 51 13
TB-1 & TB-2	Tackboard	Manufacturer: Forbo Type: Bulletin Board Size: as indicated on drawings Color: 2162 Duck egg	10 11 00
TB-1 & TB-2	Tackboard	Manufacturer: Forbo Type: Bulletin Board Size: as indicated on drawings Color: 2162 Duck egg	10 11 00
RS-1M	Standard Roller Shade 3% Openness	Manufacturer: Legrand Product: Solar Screen Housing Type: as indicated in specifications. Fabric: SheerWeave 2410, 80P0236, Oyster/Pearl Gray, 3% Openness Coordinating hembar	12 24 13
RS-2M	Standard Blackout Blind 0% Openness	Manufacturer: Legrand Housing Type: as indicated in specifications.	12 24 13

Abbreviations and Finishes			
	Description and/or Location	Basis of Design	Spec Section #
		Fabric: SheerWeave 7000 Blackout, 80P0261, Canyon, 0% Openness Coordinating hembar	
RS-3M	Dual Roller Shade 3% and 0% Openness	Manufacturer: Legrand Housing Type: as indicated in specifications. Fabric 1: SheerWeave 2410, 80P0236, Oyster/Pearl Gray, 3% Openness Fabric 2: SheerWeave 7000 Blackout, 80P0261, Canyon, 0% Openness Coordinating hembar	12 24 13

END OF SECTION

1 GENERAL

1.1 Summary

- .1 Provide Gypsum Board Assemblies in accordance with the requirements of the Contract Documents.

1.2 References

- .1 ASTM International (ASTM):
- .1 ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .2 ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength.
 - .3 ASTM A510/A510M, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel.
 - .4 ASTM A641/A641M, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .5 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .6 ASTM B221/B221M, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .7 ASTM C11, Standard Terminology Relating to Gypsum and Related Building Materials and Systems.
 - .8 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .9 ASTM C475/C475, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .10 ASTM C645, Standard Specification for Nonstructural Steel Framing Members.
 - .11 ASTM C754, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
 - .12 ASTM C834, Standard Specification for Latex Sealants.
 - .13 ASTM C840, Standard Specification for Application and Finishing of Gypsum Board.
 - .14 ASTM C919, Standard Practice for Use of Sealants in Acoustical Applications.
 - .15 ASTM C954, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
 - .16 ASTM C1002, Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - .17 ASTM C1047, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - .18 ASTM C1396, Standard Specification for Gypsum Board.
 - .19 ASTM D3273, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - .20 ASTM D5420, Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact).
 - .21 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .22 ASTM E136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
- .2 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB-19.21, Sealing and Bedding Compound for Acoustical

- .3 Canadian Standards Association (CSA):
 - .1 CAN/CSA S136, North American Specification for the Design of Cold Formed Steel Structural Members and S136.1-12 - Commentary on North American specification for the design of cold-formed steel structural members.
- .4 Alberta Wall and Ceiling Association (AWCA):
 - .1 Specification Standards Manual
- .5 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .3 CAN/ULC S114, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
 - .4 CAN/ULC S702, Standard for Thermal Insulation Mineral Fibre for Buildings.
 - .5 Underwriters' Laboratories of Canada (ULC), List of Equipment and Materials

1.3 System Description

- .1 Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ULC.
- .2 STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E413 by a testing and inspecting agency.
- .3 Load and Deflection Criteria: Interior gypsum board walls are designed to withstand a lateral loading of 240 Pa positive and negative pressure, and maximum deflection not to exceed 1/240 of the wall height. If more stringent requirements are required notify Consultant for direction.

1.4 Definitions

- .1 Levels of Finish: Standard levels of finish defined by NWCB Manual apply to products of this Section as follows:
 - .1 Level 0: No tape or joint compound in joints.
 - .2 Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, unless a higher level of finish is required for fire resistance rated assemblies and sound rated assemblies.
 - .3 Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile.
 - .4 Level 3: Embed tape and apply separate first and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will receive heavy gauge wall coverings as final decoration.
 - .5 Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view.
 - .6 Level 5: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat over entire surface for corridors, long hallways, walls and ceilings longer than 7500 mm or walls higher than 3600 mm, and for all curved or angled wall surfaces. Provide Level 5 finish to all gypsum board walls requiring paint gloss level 3, in accordance with MPI requirements.
- .2 Refer to ASTM C11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.5 Submittals

- .1 Product Data: Submit for Consultant's action product data for each type of product indicated.
- .2 Shop Drawings: Submit for Consultant's action shop drawings to show the proposed locations of items that are required, but not shown on the Drawings, including access doors, control joints, and details for isolation of framing from structure. Prepare details at not less than 1:5 minimum scale
- .3 Samples: Submit for Consultant's action samples for trim accessories, full-size sample 300 mm long for each trim accessory indicated.
- .4 Submit for Consultant's action ULC Assembly Listings and Materials cut sheets for fire rated assemblies as follows:
 - .1 Not later than 30 working days following Award of Contract, submit copies of ULC Assembly and Materials Listing for indicating ULC Number and how assembly meets the rating criteria for assemblies listed on drawings or meets requirements of Appendix D of National Building Code for review by the Consultant.
 - .2 Use the same system and material as would be required for a tested assembly for the project; ULC Listings are tested with the specific materials indicated; substitutions will not be permitted unless evidence of equivalency is confirmed.
 - .3 Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site; include manufacturer's printed instructions for installation.

1.6 Quality Assurance

- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- .2 Field Samples: Prior to the Pre-Construction Conference, provide a field sample for each type of gypsum board construction and special conditions in the building at areas to be designated by the Consultant. Utilize the same materials and installation methods in the sample as required for the final Work. Schedule the installation so that the sample may be examined, and any necessary adjustments made, at least 1 week prior to date scheduled for commencing installation of the Work. When accepted, sample areas shall serve as the standard for materials, workmanship, and appearance for such Work throughout the project and shall remain a part of the final Work.
- .3 Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of National, Provincial and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

1.7 Delivery, Storage and Handling

- .1 Deliver and store materials in manufacturer's original packaging labeled to show name, brand, type, and grade. Store materials in protected dry location off ground in accordance with manufacturer's instructions. Do not open packaging nor remove labels until time for installation.

1.8 Project/Site Conditions

- .1 Environmental Requirements: Do not start installation of gypsum board unless building is enclosed and interior spaces are continuously maintained at a uniform temperature not less than 13 degrees C from 1 week before start of gypsum board joint treatment until after the completed treatment is cured dry. Temperature requirements may be waived only on recommendation by gypsum board materials manufacturer. Provide ventilation to remove excess moisture from the air during joint treatment.

2. PRODUCTS

2.1 Performance Requirements

- .1 Fire Test Response Characteristics: Refer to Section 07 05 80; use materials identical to those listed for ULC assemblies submitted to Consultant.
- .2 Sound Transmission Characteristics: Provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by a qualified independent testing agency for STC ratings of specific assemblies indicated on Drawings.

2.2 Materials

- .1 Interior Gypsum Panels: Provide in maximum lengths and widths available that minimize joints in each area and correspond with support system as indicated on drawings, in thicknesses as indicated and as follows:
 - .1 Regular Type Gypsum Board: Meeting requirements of ASTM C1396M with long edges tapered, and as follows:
 - .1 Location: Vertical surfaces, unless otherwise indicated.
 - .2 Acceptable Materials:
 - CertainTeed, Easi-Lite
 - CGC Inc., Sheetrock
 - Georgia-Pacific Canada, Inc., ToughRock® Fireguard® 45 Gypsum Board
 - .2 Fire Resistant Type (Type X) Gypsum Board: Meeting requirements of ASTM C1396M with long edges tapered, and as follows:
 - .1 Location: Where required for fire resistance rated assembly.
 - .2 Acceptable Materials:
 - CGC Inc., Sheetrock Firecode.
 - CertainTeed Inc., Type X Gypsum Board
 - Georgia Pacific Canada, Inc., ToughRock® Fireguard® X Gypsum Board
 - National Gypsum, Gold Bond XP Fire Shield C
 - .3 Sag Resistant Gypsum Board: Meeting requirements of ASTM C1396M, ceiling board manufactured to have more sag resistance than regular type gypsum board with long edges tapered, and as follows:
 - .1 Location: Ceiling surfaces.
 - .2 Acceptable Materials:
 - CGC Sheetrock Interior Ceiling Board
 - CertainTeed Interior Ceiling Gypsum Board
 - Georgia Pacific ToughRock® Fireguard 45™ Gypsum Board or ToughRock® Span 24® Ceiling Board
- .2 Joint Treatment Materials: Provide joint compound and accessory materials in accordance with ASTM C475 and as follows:
 - .1 Joint Tape:
 - .1 Interior Gypsum Board: Paper.
 - .2 Exterior Gypsum Soffit Board: Fibreglass mesh tape.
 - .2 Joint Compound for Interior Gypsum Board: Vinyl based, non-asbestos, low dusting type compatible with other compounds applied on previous or for successive coats, and as follows:
 - .1 Pre-filling: Setting type taping compound.
 - .2 Embedding and First Coat: Drying type compound.
 - .3 Fill Coat: Drying type compound.

- .4 Finish Coat: Drying type, sandable topping compound.
- .5 Skim Coat: Drying type, sandable topping compound.
 - CGC Tough Hide Spay on Level 5 Finish.
- .3 Steel Suspended Ceiling Framing: Provide components and materials in accordance with ASTM C754 for interior conditions as indicated on Drawings, and as follows:
 - .1 Tie Wire: ASTM A641 Class 1 zinc coating, soft temper, No. 18 gauge wire.
 - .2 Hangers:
 - .1 Wire Hangers: ASTM A641, Class 1 zinc coating, soft temper, No. 8 gauge.
 - .3 Carrying Channels: Cold rolled, commercial steel sheet with a base metal thickness of 1.2 mm x 13 mm minimum wide flange, with ASTM A653, Z180, hot dip galvanized zinc coating; 38 mm minimum depth.
 - .4 Furring Channels: Commercial steel sheet with ASTM A653, Z180, hot dip galvanized zinc coating, as follows:
 - .1 Hat Shaped, Rigid Furring Channels: ASTM C645, 0.46 mm thickness x 22 mm deep.
- .4 Steel Partition Framing: Provide components and materials in accordance with ASTM C645 for conditions indicated on Drawings.
- .5 Steel Sheet Components, Steel Studs and Runners: In accordance with ASTM C645 requirements for metal and with ASTM A653, Z180, hot dip galvanized zinc coating and as follows:
 - .1 Steel Studs: Nominal 25 ga. (0.46 mm) base metal thickness, except use 20 ga. (0.75 mm) heavy weight framing to support fire rated door frames; depth as indicated on drawings, spaced at 406 mm O/c, unless noted otherwise.
 - .2 Runners: Width, thickness and galvanizing to match steel studs, and as follows:
 - .1 Slotted Deflection Track for Fire Separations: Premanufactured slotted top runner with 63 mm down standing legs and having 6 mm wide x 38 mm high slots spaced at 25 mm O/c along length of runner; tested and certified for use in fire rated wall construction:
 - Acceptable Materials:
 - Brady Construction Innovations, SliptrackSystems
 - Dietrich Metal Framing, SLP-TRK
 - .2 Double Runner Deflection Track: Outside runner using 50 mm flanges; inner runner 33 mm; maintaining 25 mm minimum deflection space.
 - .3 Base Runner: Bottom track with 33 mm upstanding legs.
 - .3 Flat Strap and Backing Plate, strapping: Steel sheet for blocking and bracing in length and width indicated; 1.2 mm nominal base metal thickness x 406 mm wide.
 - .4 Horizontal Cross Bracing: 1.2 mm nominal base metal thickness; 13 mm minimum width flange x 38 mm minimum depth.
 - .5 Clip Angle: 38 mm x 38 mm x 1.8 mm nominal base metal thickness.
 - .6 Furring Channels: Commercial steel sheet with ASTM A653, Z180, hot dip galvanized zinc coating, as follows:
 - .1 Hat Shaped, Rigid Furring Channels: ASTM C645, 0.75 mm thickness x 22 mm deep.
 - .2 Resilient Furring Channels: 0.46 mm thickness x 13 mm deep members designed to reduce sound transmission having asymmetrical face attached to single flange by a slotted leg (web).
 - .7 Fasteners for Metal Framing: Type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- .6 Interior Heavy Gauge Partition Framing: Steel stud framing for walls exceeding 5000 mm in height, and as follows:

- .1 Cold Formed Sheet Steel: Commercial steel sheet Interior members not forming a part of the exterior building envelope shall have a minimum ASTM A653, Z180, hot dip galvanized zinc coating, thickness of framing members exclusive of galvanized coating.
- .2 Studs: to CAN/CSA-S136 and shall be identified as to specification, type grade and mechanical properties; minimum 65 mm deep x 38mm wide x metal core thickness 0.75 mm spaced at 305 mm (unless noted otherwise) on centre, hot dipped galvanized steel; roll formed with knurled flanges, services and bracing cut outs.
- .3 Sill tracks: To CAN/CSA-S136, top track shall be a single track system with minimum metal core thickness 0.75 mm, hot dipped galvanized steel. Top track flanges of depth to suit vertical deflection; do not fix top of studs to track, minimum depth 38 mm and width to suit studs. Floor track to suit stud width, with 33 mm flanges.
- .4 Channel stiffener: 19 mm cold rolled channel of 1.2 mm, electro-galvanized steel.
- .5 Fasteners:
 - .1 Stud to stud: Steel, self drilling, self threading, case hardened. Material: stainless steel or steel with minimum 0.008mm cadmium or zinc coating. Head Profile: hex, pan, and low profile type. Length: adequate to penetrate not less than 3 fully exposed threads beyond joined materials.
 - .2 Track to concrete: Hilti drilled insert, sizes as specified. Do not use Powder Actuated Fasteners.
 - .3 Track to steel: Secure track to structural steel over 8 mm thickness with Hilti "DX fastening system" with "X-EDNI" nails as specified. Provide additional steel back up above interstitial steel deck for wall support.
 - .4 Drilled Inserts: Steel, cadmium plated or hot dip galvanized, sizes as indicated on drawings.
- .6 Bolts and Nuts: Meeting requirements of ASTM A307, with large flat type steel washers, sized to suit fasteners, hot dip galvanized, 413.68 MPa Tensile Strength
- .7 Welding Electrodes: Minimum tensile strength series of 480 MPa, suitable for material being welded.
- .8 Touch up Paint for galvanized surfaces: MPI #18, inorganic or SSPC-Paint 20, Type 1 Inorganic; zinc-rich primer.

2.3 Accessories

- .1 Joint Tapes: ASTM C475, plain or perforated type.
- .2 Joint Compounds: ASTM C475, in dry powder form, or pre-mixed ready for application, as especially recommended by gypsum board manufacturer for conditions of the application.
- .3 Adhesive: As recommended by the gypsum board manufacturer for adhering of gypsum board to backing material.
- .4 Acoustical Sealant: ASTM C834. Non-sag emulsion sealant. Specifically recommended by manufacturer as an acoustical sealant.
 - .1 CertainTeed Silent FX Noiseproofing Sealant
 - .2 Pecora Corporation "AC-20 FTR"
 - .3 Serious Energy, Inc. "Quiet Seal ProAC-20 + Silicone"
 - .4 Specified Technologies, Inc. "Smoke and Sound"
 - .5 Tremco Mfg. Co. "Acoustical Sealant"
- .5 Vinyl Foam Isolation Tape: Compressible, self-adhesive, non-exuding, closed cell, vinyl foam glazing tape of approximately 30 Shore 00 hardness. Nominal 6 mm thickness.
 - .1 Saint Gobain "Norseal V-980" (adhesive two sides)
 - .2 Saint Gobain "Norseal" V-780 (adhesive one side)
- .6 Trim Accessories:

- .1 Interior Trim: Galvanized coated steel sheet or rolled zinc meeting the requirements of ASTM C1047, in the following shapes:
 - .1 CB Corner Bead: Standard 0.40 mm thickness, corrosion resistant outside corner reinforcements, angle to suit installation.
 - .2 Reinforced Corner Bead: Heavy duty 0.46 mm thickness, corrosion resistant outside corner reinforcements for use at high exposure corners, angle to suit installation.
 - .3 LC Edge Bead: U-shaped trim 0.40 thickness to provide a clean finished edge; exposed long flange receives joint compound; use at exposed panel edges, and returns to adjacent materials.
 - .4 Expansion Joints: Back-to-back edge beads at joints spanning building expansion and movement joints.
 - .5 Control Joints: V-shaped trim having strippable joint protection specifically manufactured to provide thermal stress relief to large ceiling and wall areas; confirm locations with Consultant before installation.
 - .6 Strippable Edge Trim: Extruded PVC with pre-masked L-shaped tape on trim with tear away protective serrated strip for removal after compound and paint is applied, for use at areas where gypsum butts aluminum frames and where gypsum butts concrete or concrete block.
 - .7 Bullnose Bead: Architecturally finished corners and transitions, used only where detailed.
 - .8 Acceptable Materials:
 - Dietrich Industries, Metal Trims and Finishing Products
 - Other materials may be acceptable provided information is sent to and accepted by the Consultant before installing products required by this Section.
- .2 No Coat drywall corner: severe impact resistant, high strength tapered copolymer core, ASTM C1047, ASTM C475 and ASTM C840. Basis-of-Design: CertainTeed NO COAT Drywall Corners.
- .3 Aluminum Trim: Extruded accessories of profiles and dimensions indicated:
 - .1 Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221 alloy 6063-T5.
 - .2 Finish: Clear anodized compatible with joint compound and finish materials.
- .7 Acoustic Materials: Coordinate placement of acoustic materials with wall assembly types. Use only fire rated materials in fire and smoke rated assemblies. Acoustic sealants shall be applied prior application of fire and smoke seals specified in Section 07 84 00 and as follows:
 - .1 Acoustic Sealant for Exposed Joints: Non-sag, paintable, non-staining, latex sealant in accordance with ASTM C834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction:
 - .1 Basis-of-Design Materials: Pecora Corp., AC-20 FTR Acoustic and Insulation Sealant.
 - .2 Acoustic Sealant for Concealed Joints: Non-drying, non-hardening, non-skinning, non-staining, gunnable, synthetic rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission:
 - .1 Acceptable Materials:
 - CertainTeed Silent FX Noiseproofing Sealant
 - Pecora Corp., BA-98.
 - Tremco, Acoustical Sealant
- .8 Acoustic Insulation for Fire and Smoke Rated Assemblies: Meeting the requirements of ULC S702 mineral fibre acoustic sound batts, Type 1 for all properties except thermal performance, width to friction fit steel studs; un-faced, thickness minimum 89 mm to fill a minimum of 90% of the cavity thickness, nominal density 40 kg/m³ minimum; STC ratings as indicated on drawings; having maximum flame spread and smoke developed of 20/20 in accordance with CAN/ULC S102 and being non-combustible in accordance with CAN/ULC S114:

- .1 Acceptable Materials:
 - .1 Owens-Corning Canada Inc., Quietzone Fire Batts
 - .2 Rockwool Inc., Roxul AFB Acoustical Fire Batt

- .9 Acoustic Insulation for Non-Rated Assemblies: Meeting the requirements of ASTM C423, ASTM E90 and ASTM E413, and ULC S702 mineral fibre acoustic sound batts, Type 1 for all properties other than thermal, width to friction fit steel studs; un-faced, thickness to fill a minimum of 90% of the cavity thickness, nominal density 12.2 kg/m³ minimum; STC ratings as indicated on drawings:
 - .1 Acceptable Materials:
 - .1 CertainTeed Noise Reducer
 - .2 Owens-Corning Canada Inc., Quietzone Acoustical Batts
 - .3 Johns-Manville Sound Shield Glass Fibre Batts

- .10 Auxiliary Materials: Provide auxiliary materials in accordance with referenced installation standards and manufacturer's written recommendations, and as follows:
 - .1 Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 - .2 Steel Drill Screws: ASTM C1002, unless otherwise indicated, except use screws in accordance with ASTM C954 for fastening panels to steel members from 0.75 mm to 2.67 mm thickness, and as follows:
 - .1 Type S: Shallow pitch screw; used for single layer gypsum board application
 - .2 Type G: Steep pitch screw; used for double layer gypsum board application
 - .3 Isolation Strip at Exterior Walls: Adhesive backed, closed cell vinyl foam strips that allow fastener penetration without foam displacement, 3 mm thick, in width to suit steel stud size.
 - .4 Access Panels: Refer to Section 08 31 00, rated to suit wall or ceiling fire rating.

3. EXECUTION

3.1 Examination

- .1 Examine areas and substrates, with Installer present, and including welded hollow metal frames, cast in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Preparation

- .1 Suspended Ceilings:
 - .1 Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.
 - .2 Furnish inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction where concrete inserts are required.

- .2 Foam Deck Inserts:
 - .1 Coordinate with fire resistive foam deck inserts, firestopping and smoke seal materials specified in Section 07 84 00.
 - .2 Install specified materials in accordance with material manufacturer's written instructions.

- .3 Access Panels and Doors:

- .1 Coordinate access panels and wall types with materials specified in Section 08 31 00.
 - .2 Coordinate with Mechanical and Electrical for locations and size requirements of access panels.
 - .3 Coordinate and confirm location of access panels before installation with Consultant.
 - .4 Install specified materials in accordance with material manufacturer's written instructions.
- .4 Fire Rated Construction:
- .1 Install materials forming a part of fire rated construction in accordance with manufacturer's instructions and as required to meet specific ULC listed construction requirements submitted by Subcontractor.
 - .2 Install fire rated gypsum wall panels vertically; horizontal installation does not meet testing standard unless horizontal blocking is installed behind horizontal joints.
- .5 Cold Weather Application of Gypsum Board:
- .1 Install gypsum board and joint compound in accordance with NWCB requirements and manufacturer's instructions.
 - .2 Provide temporary heat and moisture control for a period sufficiently in advance of gypsum board and joint compound application to allow building and substrates to acclimate to installation temperature and moisture range required by manufacturer.
 - .3 Maintain temporary heat until permanent building heating system is started and continuously running.
 - .4 Provide suitable ventilation to allow materials to dry properly; prevent excessive air movement that could dry materials too quickly and that could cause shrinkage cracking.
- 3.3 Installing Steel Framing
- .1 Installation Standards: ASTM C754, and ASTM C840 requirements that apply to framing installation.
 - .2 Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. In accordance with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with NWCB, Specification Standards Manual.
 - .3 Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement, and as follows:
 - .1 Isolate ceiling assemblies where they abut or are penetrated by building structure.
 - .2 Isolate partition framing and wall furring where it abuts structure, except at floor.
 - .3 Install double runner deflection track at head of assemblies that avoid axial loading of assembly and laterally support assembly.
 - .4 Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.
 - .5 Installing Steel Suspended Ceiling Framing: Suspend ceiling hangers from building structure as follows:
 - .1 Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter splaying, or other equally effective means.
 - .2 Install supplemental suspension members and hangers in form of trapezes or equivalent devices where width of ducts and other construction within ceiling plenum produces hanger spacing that interfere with the location of hangers required to support standard suspension system members.
 - .3 Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

- .4 Secure wire hangers by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
- .5 Secure rod, flat or angle hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail:
 - .1 Do not attach hangers to steel deck tabs.
 - .2 Do not attach hangers to steel roof deck. Attach hangers to structural members. Provide additional carrier channels between structural elements where structure does not align with hangers.
 - .3 Do not connect or suspend steel framing from ducts, pipes, or conduit.
- .6 Install steel framing components for suspended ceilings so members for panel attachment are level to within 3 mm in 3600 mm measured lengthwise on each member and transversely between parallel members.
- .7 For exterior soffits, install bracing and framing to resist wind uplift.
- .8 Wire-tie furring channels to supports, as required in accordance with requirements for assemblies indicated. Clips will not be acceptable.
- .9 Install suspended steel framing components in sizes and spacing indicated, but not less than that required by the referenced steel framing and installation standards:
 - .1 Hangers: 1220 mm ^O/c.
 - .2 Carrying Channels (Main Runners): 1220 mm ^O/c.
 - .3 Furring Channels (Furring Members): 406 mm ^O/c.
- .6 Installing Steel Partition Framing: Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction:
 - .1 Install foam gasket isolation strip between studs where studs are installed directly against exterior walls.
 - .2 Install each steel framing and furring member so fastening surfaces vary not more than 3 mm from the plane formed by the faces of adjacent framing.
 - .3 Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board:
 - .1 Cut studs 13 mm short of full height to provide perimeter relief.
 - .2 For fire resistance rated and STC rated partitions that extend to the underside of floor slabs and roof decks or other continuous solid structure surfaces: Install framing around structural and other members extending below floor slabs and roof decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
 - .3 Terminate partition framing at suspended ceilings where indicated.
 - .4 Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
 - .5 Install horizontal cross bracing to steel studs at 1220 mm ^O/c vertically for the entire length of wall for unbraced walls exceeding 3660 mm in length.
 - .6 Frame door openings using 0.75 mm steel studs and in accordance with gypsum board manufacturer's applicable written recommendations:
 - .1 Screw vertical studs at jambs to jamb anchor clips on door frame; install runner track section (for cripple studs) at head and secure to jamb studs.
 - .2 Install two studs at each jamb, connected for entire length.
 - .3 Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
 - .7 Frame openings other than door openings the same as required for door openings. Install framing below sills of openings to match framing required above door heads.

3.4 Access Panels

- .1 Install access panels in wall assemblies to maintain fire rating of assembly.
- .2 Confirm location of access panels with the Consultant before installation.
- .3 Minor adjustments to location within wall system may be required where panel interferes with architectural appearance.

3.5 Applying and Finishing Panels

- .1 Gypsum Board Application and Finishing Standards: ASTM C840.
- .2 Panel Application Methods:
 - .1 Single Layer Application:
 - .1 On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing.
 - .2 On partitions, apply gypsum panels vertically (parallel to framing), unless horizontal application is indicated or otherwise required by fire resistance rated assembly, and to minimize end joints.
 - .3 Stagger abutting end joints not less than one framing member in alternate courses of board.
 - .4 At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire resistance rated assembly.
 - .5 Apply gypsum panels to supports using Type S screws fastened 10 mm from edges of board.
 - .6 Apply gypsum board to assemblies having resilient channels using Type S screws fastened 38 mm from edges of boards.
 - .2 Double Layer Application:
 - .1 Apply first layer with enough screws to hold panel in place.
 - .2 Stagger and offset joints of second layer from first layer.
 - .3 Apply second layer over first layer and secure as specified for single layer application using screws long enough to penetrate both layers and penetrate 10 mm into metal framing.
- .3 Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- .4 Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling; stagger abutting end joints of adjacent panels not less than one framing member spacing.
- .5 Install gypsum panels with face side out; butt panels together for a light contact at edges and ends with not more than 1.5 mm of open space between panels; do not force into place.
- .6 Locate edge and end joints over supports:
- .7 Do not place tapered edges against cut edges or ends.
- .8 Stagger vertical joints on opposite sides of partitions.
- .9 Do not make joints other than control joints at corners of framed openings.
- .10 Stop gypsum board away from underside of floor above and roof deck to allow for deflection of structure.

- .11 Attach gypsum board to vertical studs, not to ceiling track, to allow for deflection.
- .12 Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- .13 Attach gypsum panels to framing provided at openings and cut outs.
- .14 Form control joints to account for thermal movements, to account for movement where direction of framing changes direction, and movements arising differing substrate materials using V-Shaped trims by framing back-to-back framing members and a break in gypsum panel at a maximum of 7.5 metres O/C, as follows:

- .1 Install control joints in wall and ceiling construction in accordance with ASTM C840 so that gross area enclosed by joints does not exceed 80 m² between joints using limiting distances as follows:

Partition Type	Maximum Single Dimension
Interior Partitions	9 metres
Interior Ceilings with Perimeter Relief	15 metres
Interior Ceilings without Perimeter Relief	9 metres
Exterior Ceilings	9 metres
Exterior Walls	9 metres

- .2 Lay out control joints to coincide as far as possible with door, window or screen frames, but not necessarily to occur at every individual frame; install control joints vertically and horizontally from corners of openings.
 - .3 Provide continuous dust barrier behind joints.
 - .4 Install joints straight and true.
 - .5 Form control joints to meet sound rated construction and fire ratings required for remainder of wall or ceiling construction.
 - .6 Obtain Consultant's acceptance of control joint layout before starting installation of materials specified in this Section.
- .15 Form expansion joints to account for building movements using back-to-back framing members and edge trims, and a break in gypsum panel over structural movement joints and floor slab control joints as follows:
 - .1 Install expansion joints incorporating continuous air and vapour membranes and with sufficient gap to allow for projected building movements.
 - .2 Seal back-to-back edge bead control joints with clear silicone sealant as specified in Section 07 92 00.
 - .3 Provide continuous dust barrier behind joints.
 - .4 Install joints straight and true.
 - .5 Form expansion joints to meet sound rated construction and fire ratings required for remainder of wall or ceiling construction.
 - .16 Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally:
 - .1 Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 0.7 m² in area.
 - .2 Fit gypsum panels around ducts, pipes, and conduits.
 - .3 Cut gypsum panels to fit profile formed by coffers, joists, and other structural members where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks; allow 6 mm to 10 mm wide joints to install sealant.

- .17 Isolate perimeter of non-load bearing gypsum board partitions at structural abutments, except floors. Provide 6 mm to 13 mm wide spaces at these locations, and trim edges with J-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustic sealant.
 - .18 Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations, and as follows:
 - .1 Space screws a maximum of 300 mm O/c for vertical applications.
 - .2 Space fasteners in panels that are tile substrates a maximum of 200 mm O/c.
 - .19 Install fire rated and labelled gypsum board at all locations indicated on Drawings; continue fire and smoke rated wall construction behind and around fire hose cabinet recesses and other recessed items larger than a double gang switch box to maintain wall fire rating.
 - .20 Install sheet metal backing where required for mounting of items. Spot glue sheet in place before applying surface layer of gypsum board.
 - .21 Finishing Gypsum Board Assemblies:
 - .1 Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
 - .2 Pre-fill open joints, rounded or bevelled edges, and damaged surface areas.
 - .3 Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
 - .4 Provide the finish level, specified in ASTM C840, for the following surfaces:
 - .1 Level 1: plenum areas above ceilings and other concealed areas.
 - .2 Level 2: surfaces that are to receive ceramic tile.
 - .3 Level 3: surfaces that are to receive heavy spray or trowel applied finishes.
 - .4 Level 4: surfaces to receive wallcoverings, flat paints or light textures.
 - .5 Level 5: surfaces to receive vinyl wall coverings.
 - .5 Water Resistant Gypsum Board: Do not tape or fill joints in water resistant gypsum board used as a substrate for ceramic tile.
 - .6 Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed vertically applied wall sheathing.
- 3.6 Acoustic Installation
- .1 STC Rated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustic sealant. Install acoustic sealant at both faces of partitions at perimeters and through penetrations. In accordance with ASTM C919 and manufacturer's written recommendations for locating edge trim and closing off sound flanking paths around or through gypsum board assemblies, including sealing partitions above acoustic ceilings.
 - .2 Acoustic Sealants:
 - .1 Seal sound rated partitions in strict in accordance with gypsum board manufacturer's instructions for the specific sound rating requirements. Provide two (2) beads of sealant where no sealants are indicated; one under each inner and outer layer of gypsum board.
 - .2 Locate sealant to ensure it is covered at completion of partition when finishes applied; use appropriate sealant for exposed locations.
 - .3 Seal around mechanical and electrical work and other work in walls to ensure proper sound ratings.
 - .4 Provide gaskets where partitions abut a finished surface or material and where partitions meet exterior wall furring.
 - .5 Build in all door and borrowed light frames and equipment to provide a neat, cleanly finished system.

- .6 In fire rated partitions use firestopping sealant instead of acoustic sealant to maintain required sound ratings. Zero rated smoke separations shall be constructed the same as for fire rated partitions.
- .3 Acoustic Sound Batts:
 - .1 Install acoustic sound batts within metal stud space and above suspended gypsum board ceilings as indicated for sound or fire rating.
 - .2 Acoustic sound batts to extend full height of partitions.
 - .3 Fill behind electrical outlet boxes, fire hose cabinets, washroom accessories and other openings with at least 150 mm lap around perimeter of opening; do not compress acoustic sound batts as this could cause the gypsum board finish to bulge or push outward.
 - .4 Coordinate with Electrical and Mechanical Subcontractors and verify that no back-to-back openings are formed, whether or not so indicated on drawings.
 - .5 Installation in accordance with manufacturer's current written recommendations.
- 3.7 Fire Rating Sealant Installation
 - .1 Seal fire rated partitions strictly in accordance with fire sealant manufacturer's instructions for specific fire rating requirements listed; coordinate with Section 07 84 00.
 - .2 Locate sealant to ensure it is covered at completion of partition when finishes applied.
 - .3 Seal around mechanical and electrical work and other work in wall to ensure proper fire rating.
- 3.8 Installing Trim Accessories
 - .1 For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
 - .2 Control Joints: Install control joints at locations indicated on Drawings, confirm locations of joints with Consultant before construction, and in accordance with ASTM C840 and in specific locations approved by Consultant for visual effect where joints are not otherwise indicated.
 - .3 Reveals: Cut vertical trims and casing beads at horizontal reveal locations, and install horizontal reveals continuous around corners and edges.
- 3.9 Site Quality Control
 - .1 Above Ceiling Observation: Before installing gypsum board ceilings, Consultant will conduct an above ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected:
 - .1 Notify Consultant seven (7) working days in advance of date and time when Project, or part of Project, will be ready for above ceiling observation.
 - .2 Before notifying Consultant, complete the following in areas to receive gypsum board ceilings:
 - .1 Installation of 80% of lighting fixtures, powered for operation.
 - .2 Installation, insulation, and leak and pressure testing of water piping systems.
 - .3 Installation of air duct systems.
 - .4 Installation of air devices.
 - .5 Installation of mechanical system control air tubing.
 - .6 Installation of acoustic isolation system.
 - .7 Installation of ceiling support framing.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide Gypsum Board Shaft Wall Assemblies in accordance with requirements of Contract Documents.

1.2 References

.1 ASTM International (ASTM):

- .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 ASTM C475/C475M, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- .3 ASTM C645, Standard Specification for Nonstructural Steel Framing Members.
- .4 ASTM C1002, Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- .5 ASTM C1396/C1396M, Standard Specification for Gypsum Board.
- .6 ASTM C1658/C1658M, Standard Specification for Glass Mat Gypsum Panels.
- .7 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .8 ASTM E413, Classification for Rating Sound Insulation.

.2 Northwest Wall and Ceiling Bureau (NWCB):

- .1 Specification Standards Manual

.3 Underwriters Laboratories of Canada (ULC):

- .1 CAN/ULC S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials.
- .2 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .3 ULC List of Equipment and Materials
- .4 Underwriters' Laboratories (UL), Standards for Safety acceptable to the Standards Council of Canada (SCC)

1.3 Submittals

.1 Product Data: Submit for Consultant's action as follows:

- .1 Submit product data indicating compliance with deflection, loading and fire resistance ratings required by this Section; identify any changes to standard systems and assemblies that may be required to meet project requirements.

.2 Design Submittals: Submit for Consultant's action:

- .1 Design Submittals: Submit written design information acceptable to Authorities Having Jurisdiction to Consultant before to starting construction of shaft wall assemblies.

1.4 Quality Assurance

.1 Regulatory Requirements:

- .1 Provide materials and construction identical to those tested in assembly indicated according to CAN/ULC S101, and labelled and listed by UL, ULC or ITS/Warnock Hersey, or another independent testing and inspection agency acceptable to Authorities Having Jurisdiction for fire resistance ratings of specific assemblies indicated on Drawings and as specified in Section 07 05 80.
- .2 Provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by a qualified independent testing agency for STC ratings of specific assemblies indicated on Drawings.

.2 Qualifications: Provide proof of qualifications when requested by Consultant:

- .1 Installation Requirements: Conform to product manufacturer's written instruction and ULC Design Requirements to provide STC and fire ratings required for project.

.3 Certifications: Provide the following during the course of the Work:

- .1 Compliance Certification: Provide certificates from manufacturer indicating tested performance requirements required by Authorities Having Jurisdiction.

1.5 Delivery, Storage and Handling

.1 Delivery and Acceptance Requirements: Deliver materials in undamaged, original factory wrappings with labels and seals intact and stored on job site in a dry, weatherproof, heated area.

.2 Storage and Handling Requirements:

- .1 Store materials flat, blocked off the ground in a manner to prevent kinking or permanent set.
- .2 Store boards flat, in piles, without overhanging boards, protected from moisture and physical damage.

1.6 Site Conditions

.1 Ambient Conditions: Maintain room, surface and material within temperature range and for duration before, during and after application in accordance with manufacturer's written requirements.

2. PRODUCTS

2.1 Design

.1 Design mechanical shaft walls, and other vertical or horizontal shaft walls for maximum deflection as follows:

- .1 Deflection: Use L/360 Modulus for deflection under sustained load.
- .2 Fire Rating: Design shaft wall in accordance with ULC requirements to attain fire ratings indicated on Drawings.
- .3 Deflection: Use L/240 Modulus for deflection under intermittent load.
- .4 End Reaction and Bending Stress: Do not exceed maximum allowable for given stud height.
- .5 Fire Rating: Design hoistway in accordance with ULC requirements to attain fire ratings indicated on Drawings.

2.2 Materials

- .1 Gypsum Shaft Liner Boards: Meeting requirements of ASTM C1396 and ASTM C1658; ULC fire rated; maximum permissible length and width; end square cut, bevelled edges; fibreglass mat glass faced; 19 mm or 25 mm thickness to suit manufacturers standard system and fire rating indicated on Drawings
 - .1 Acceptable Materials:
 - .1 Georgia-Pacific Canada, Inc., DensGlass Shaftliner Type X
 - .2 CertainTeed, GlasRoc Shaftliner Type X
 - .3 CGC Sheetrock Brand Glass-Mat Liner Panel Type SLX
 - .2 Gypsum Face Boards: Meeting requirements of ASTM C1396 and ASTM C1658, meeting requirements of specified ULC assembly, ULC fire resistant type (Type X or Type C); thickness as indicated on Drawings.
 - .3 Shaft Wall Framing System: To ASTM C645 manufacturer's standard shaft wall steel framing system having ASTM A653M, Z180, hot-dip galvanized zinc coating; minimum steel thickness of 0.46 mm thick or heavier as required by detailed design required by 1.2.3.1 above for indicated spans; including head and bottom rails, channels, trim and accessories required for a complete installation:
 - .1 CGC Inc., C-H Stud Framing System
 - .2 Georgia-Pacific Canada, Inc., C-T Stud Framing System
 - .3 CertainTeed, Series IV – I Studs
 - .4 Fastening Devices: Screws to ASTM C1002 type S or other approved devices of type and size to suit application and to rigidly secure furring, framing and boards in place.
 - .5 Insulation: Mineral fibre batts conforming to ULC Guide No. 40U18.2, 38 mm thick, 40 kg/m³ sheets 610 mm wide, secured as detailed in referenced guide.
 - .6 Joint Tape: To ASTM C475, perforated paper with tapered edges as recommended by gypsum board manufacturer.
 - .7 Joint Compound: To ASTM C475, bedding and finishing types recommended by gypsum board manufacturer; casein, vinyl or latex base.
 - .8 Corner and Casing Beads: To ASTM C645, minimum 0.43 mm core thickness galvanized sheet steel to ASTM A653M with Z275 zinc finish, type with perforated flanges, to be finished with joint compound.
 - .9 Sealant: Refer to Section 07 84 00 and Section 07 92 00.
 - .10 Access Panels: Refer to Section 08 31 00, rated to suit shaft wall fire rating.

3. EXECUTION

3.1 Installation

- .1 Install in accordance with the manufacturer's written instructions and the contract documents, plumb, true, level and rigid.
- .2 Sequence installation in accordance with manufacturer's instructions to achieve a system that is finished from one side and constructed from the other side.

- .3 Erect gypsum board and tape joints to NWCB standards, minimum 3 coats, Level 4 finish.
- .4 Sealant: Seal perimeters of shaft wall; as well as all penetrations, to prevent air whistling and to maintain sound rating, using flexible sealant specified under Section 07 84 00.
- .5 Access Panels:
 - .1 Install access panels in shaft wall to maintain fire rating of assembly.
 - .2 Confirm location of access panels with the Consultant prior to installation.
 - .3 Minor adjustments to location within wall system may be required where panel interferes with architectural appearance.

END OF SECTION

1 GENERAL

1.1 Summary

- .1 Provide tiling in accordance with requirements of the Contract Documents.

1.2 References

- .1 American National Standards Institute/Ceramic Tile Institute (ANSI/CTI):
- .1 ANSI A108/A118/A136.1, American National Specifications for the Installation of Ceramic Tile.
 - .2 ANSI A137.1, Standard specification for ceramic tile
- .2 ASTM International (ASTM):
- .1 ASTM C627, Standard Test Method for Evaluating Ceramic Floor Tile Installation Systems Using the Robinson-Type Floor Tester.
 - .2 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .3 ASTM E303, Floor and Road Slip Resistant Testing, Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
- .3 Terrazzo, Tile and Marble Association of Canada (TTMAC):
- .1 Specification Guide 09 30 00, Tile Installation Manual.
 - .2 Hard Surface Maintenance Guide

1.3 Administrative Requirements

- .1 Pre-Construction Meeting: Arrange a pre-construction meeting, to discuss installation techniques, confirm compatibility of materials, identify any concerns arising from site conditions and identify any concerns of the installer or supplier, attended by Contractor, tile installer and tile supplier, mortar and grout representative and crack control membrane representative.

1.4 Submittals

- .1 Product Data: Submit manufacturer's product data for each type of product specified. Data shall indicate compliance with specification and installation recommendations of manufacturer of products being used.
- .2 Samples for Verification: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for colour and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Furnish samples of each type and color of tile, not less than 300 x 300 mm on plywood or hardboard backing, and grouted as required.
- .3 Closeout Submittals: Submit for Owner's documentation:
- .1 Furnish specified warranty.
 - .2 Furnish specified maintenance data.

1.5 Quality Assurance

- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.

- .2 Field Samples: Prior to the Pre-Construction Conference, provide a field sample for each type ceramic tile in the building at areas to be designated by the Consultant. Utilize the same materials and installation methods in the sample as required for the final Work. Schedule the installation with allowance for sufficient curing time so that the sample may be examined, and any necessary adjustments made, at least 1 week prior to date scheduled for commencing installation of the Work. When accepted, sample areas shall serve as the standard for materials, workmanship, and appearance for such Work throughout the project and shall remain a part of the final Work.
 - .3 Mock-up: Provide mock-up of tile area indicated on drawings. Provide Consultant 72 hours notice prior to mock-up being completed; provide 10 days to Consultant of mock-up intended location and submit shop drawings of mock-up for review prior to starting mock-up on site. Mock-up shall be complete with mortar, grout and tile. Mock-up shall remain in place on site after Consultant's review and become the standard which tile installations will be reviewed.
 - .4 Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of National, Provincial and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.
 - .5 Qualifications:
 - .1 Standard of the work of this Section: Provide materials and workmanship in accordance with recommendations of Terrazzo, Tile and Marble Association of Canada (TTMAC) and the requirements of the ANSI A108.1 Series of Standards.
 - .2 Supplier: Obtain materials from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties.
 - .3 Materials: Tile that does not meet a Grade 1 Standard, or is marked as a factory second or discount will be rejected, immediately removed from the site and replaced with specified materials.
 - .4 Installers: Execute Work of this Section using qualified personnel skilled in ceramic tile installation, having a minimum of five (5) years proven experience and have completed tile installations similar in material, design, and extent to that indicated for this Project.
- 1.6 Delivery, Storage, and Handling
- .1 Delivery and Acceptance Requirements: Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use in accordance with ANSI A108.1 for labelling sealed tile packages.
 - .2 Storage and Handling Requirements: Store materials to prevent damage or contamination to materials by water, freezing, foreign matter, and other causes; store cementitious materials in a dry area, and blocked off floor and ground surfaces.
- 1.7 Site Conditions
- .1 Environmental Requirements: Do not install tile materials unless temperature and humidity conditions closely approximate the interior conditions which will exist when the building is occupied. Maintain proper temperature/humidity conditions before, during, and after installation.
- 1.8 Maintenance
- .1 Maintenance Manuals: Submit for Owner's documentation. Furnish complete manuals describing the materials and procedures to be followed in cleaning and maintaining the Work. Include manufacturers' brochures and instruction sheets describing the actual products used in the Work, including tile, adhesive, mortar, grout, sealer, and related components.
 - .2 Extra Materials: Furnish 1 box of extra tile for each size, pattern and colour of tile installed in the Work. Deliver to the Owner in manufacturer's original packaging and store at the project site where directed.

2. PRODUCTS

2.1 Materials

- .1 Provide tile products manufactured in accordance with ANSI 137.1 or ANSI A108.1 as appropriate to the Basis-of-Design Materials.
- .2 Factory blend tile that exhibits colour variations within the ranges selected and package so tile units taken from one package show the same range in colours as those taken from other packages.
- .3 Performance Requirements:
 - .1 Static Coefficient of Friction: Provide tile with slip-resistant finish to obtain a dynamic coefficient of friction (DCOF) not less than 0.42 on level walking surfaces, measured in accordance with ANSI A137.1 DCOF AcuTest test methods.
 - .2 Load-Bearing Performance: Provide installations rated for the following load-bearing performance in accordance with ASTM C627 for ceramic tile installed on walkway surfaces:
 - .1 Heavy: Passes cycles 1 through 12.
 - .3 Floor Level Tolerances: Provide materials to attain floor levelness tolerances required by this Section; calculate quantity of materials based on the difference between the specified tolerance and the initial tolerance specified in Section 09 61 01; measurements will be made in the same manner as used in Section 09 61 01.

2.2 Wall and Floor Tile

- .1 Tile Quality: ANSI A137.1, Standard Grade, and matching the accepted samples in every respect. Obtain each type and color of tile from a single source to prevent variations in appearance and quality.
- .2 Wall Tile: Non-vitreous body with minimum absorption of 7%, cushion edged. in accordance with ANSI A137.1. Provide trim shapes as required to make a complete installation, and matched to the type, size, and color of adjoining field units.
 - .1 WT-1, WT-2, WT-3: Refer Section 09 06 06.

2.3 Trims

- .1 Provide tile trim shapes and profiles to match colour and finish of adjoining site tile.
- .2 Transition Strips as indicated on Drawings and as follows:
 - .1 Straight Edge: Extruded clear satin anodized aluminum edge strips, 3 mm wide at top edge; height as required to suit tile installation; with integral perforated anchoring leg for setting the strip into the setting material:
 - .1 Basis-of-Design Materials: Schlüter Schiene AE
 - .2 Transition Edge Strips: Extruded clear satin anodized aluminum edge strips; height as required to suit tile installation; with integral perforated anchoring leg for setting the strip into the setting material and sloped transition:
 - .1 Basis-of-Design Materials: Schlüter Reno Schiene, Schlüter Reno Ramp, Schlüter Reno. Refer to Section 09 06 06 for TS-2.
 - .3 Transition Edge Strips: for walls: Schlüter Jolly and Schlüter ECK; as indicated Section 09 06 06 with WT-1, WT-2, WT-3.

2.4 Accessory Materials

- .1 Temporary Protective Coating: Provide material formulated to protect exposed surfaces of tile against adherence of mortar and grout; is compatible with tile, mortar, and grout products; and is easily removable after grouting is completed without damaging grout or tile:
 - .1 Petroleum paraffin wax, fully refined and odourless; containing at least 0.5% oil with a melting point of 49°C to 60°C.
 - .2 Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as a temporary protective coating for tile.
- .2 Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers and as follows:
 - .1 Job Site Cleaner: Phosphoric acid/nitric acid based cleaning solution mixed in accordance with cleaner manufacturers recommendations and as recommended by tile manufacturer.
 - .2 Maintenance Cleaner: Non-toxic, electrolytic, biodegradable, non-ammonia containing, pH controlled cleaning solution mixed in accordance with manufacturer's recommendations.
 - .3 Slip Resistant Treatment Cleaner: Maintenance cleaner specific to material listed in **Error! Reference source not found.**; concentrated self neutralizing:
 - .1 Basis-of-Design Materials: No-Skidding [[Flexclean](#)] [[On Guard](#)].

2.5 Mortar Setting Materials

- .1 Interior Wall System: Large panelling thin wall tile. One-component, high-performance, highly-deformable, lightweight cementitious mortar. Meeting the requirements of ANSI A118.15.
 - .1 Acceptable Materials:
 - .1 Custom Building Products, ProLite
 - .2 Flextile Ltd., Flextile 66 FlexLite C2
 - .3 Laticrete 254 Platinum
 - .4 MAPEI Inc. Ultralite S2

2.6 Grout

- .1 Match colours listed in finish identification schedule on Section 09 06 06.
- .2 Epoxy Grout for Walls: Water cleanable, chemical resistant, factory blended modified portland cement compound with 100% epoxy additives and hardeners meeting requirements of ANSI A118.3 and ANSI A118.5:
 - .1 Acceptable Materials:
 - .1 ARDEX Engineered Cements; ARDEX WA Epoxy Grout and Adhesive
 - .2 Custom Building Products CEG-Lite Epoxy Grout
 - .3 Flextile Ltd., Flex Epoxy 100 Grout
 - .4 Laticrete SpectraLOCK PRO Premium
 - .5 MAPEI Inc. Kerapoxy CQ

2.7 Mixing Mortars and Grout

- .1 Mix mortars and grouts in accordance with referenced standards, and mortar and grout manufacturers' written instructions.
- .2 Add materials, water, and additives in accurate proportions.

- .3 Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.
- .2 Verify that concrete substrates have been allowed to cure for a minimum of 90 days in accordance with TTMAC requirements.

3.2 Preparation

- .1 Substrates: Clean the substrates to remove dirt, loose particles, coatings and deleterious matter which would impair the Work. Concrete surfaces shall be free from curing compounds or form release oils. Where necessary, use chemical cleaners, blast cleaning or other suitable methods. Dry the substrates as required to make completely free of moisture detrimental to installation of the Work.

3.3 Preparation New Installations

- .1 Make backing surfaces level and true to a tolerance in plane of ± 3 mm in 2440 mm for walls.
- .2 Use trowelable levelling and patching compounds in accordance with tile setting material manufacturer's written instructions to fill cracks, holes, and depressions.
- .3 Remove protrusions, bumps, and ridges by sanding or grinding.

3.4 Installation

- .1 Install tiling in accordance with requirements of TTMAC Tile Installation Manual and parts of ANSI A108 Series of tile installation standards that apply to types of setting and grouting materials, and to methods required for complete ceramic tile installation.
- .2 Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions:
 - .1 Terminate Work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
 - .2 Cut edges smooth, even and free from chipping.
 - .3 Do not split tile.
- .3 Accurately form intersections and returns; perform cutting and drilling of tile without marring visible surfaces:
 - .1 Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints.
 - .2 Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile.
- .4 Lay tile in pattern indicated on Drawings and as follows:
 - .1 Align joints when adjoining tiles on floor, base, walls, and trim are the same size.
 - .2 Lay out tile Work and centre tile sites in both directions in each space or on each wall area.

- .3 Centre tile patterns between control and movement joints. Notify the Consultant for further instructions where tile patterns do not align with control or movement joints.
 - .4 Cut tile accurately and without damage.
 - .5 Smooth exposed cut edges with abrasive stone, where exposed.
 - .6 Chipped or split edges are not acceptable.
 - .7 Minimum tile width: 1/2 unit unless specifically indicated otherwise on Drawings.
 - .8 Adjust tile layout to minimize tile cutting.
 - .9 Provide uniform joint widths.
 - .10 Lay out tile wainscots to next full tile beyond dimensions indicated.
- .5 Press setting material into the back of tile having raised or textured backs to provide a minimum of 95% coverage:
- .1 Set tile in place while bond coat is wet and tacky before it has skinned over.
 - .2 Notch bond coat in horizontal straight lines and set on freshly set setting material while moving tile back and forth at 90° to the notches.
 - .3 Fully support corners and edges of tile with setting material.
 - .4 Set tile with, maximum lippage of 1 mm over a 3 mm wide joint.
- .6 Prevent rapid drying of setting material:
- .1 Do not set tile on dry bed.
 - .2 Sound tile after setting and replace any hollow sounding units to obtain full bond.
- .7 Provide additional ventilation as required.
- .8 Clean excess setting materials from surface of tiles before final set.
- .9 Sound tiles after setting material have cured and replace hollow sounding tile before grouting.
- .10 Joint Widths: Install tile with joint widths as detailed on Drawings, or as follows:
- .1 Ceramic Mosaic Tile: 1.5 mm
 - .2 Wall Tile: 1.5 mm
 - .3 Porcelain Tile: 3 mm
 - .4 Make joints consistent width and alignment within tile area.
 - .5 Maintain 2/3 of grout joint depth free of setting material.
- .11 Back Buttering: Obtain minimum 85% mortar coverage in accordance with applicable requirements for back buttering of tile in referenced TTMAC and ANSI A108 series of tile installation standards for one or more of the following applications:
- .1 Tile having tiles 305 mm or larger in any direction
 - .2 Tile having tiles with raised or textured backs
 - .3 Tile having tile installation rated for Heavy or Extra Heavy Duty.
 - .4 All porcelain tiles with more than 20% of the tile backs covered with "white firing release" shall be "back buttered" so that 100% of the back is covered with adhesive mortar rated for C627, Extra Heavy Duty rating.
- .12 Install prefabricated edge strips and control at locations indicated or where exposed edge of floor tile meets different flooring materials and exposed substrates.
- .13 Install edge strip on exposed edges of tile wall base.
- .14 Protect exposed edges of floor tile with properly sized transition strips, use sloped reducer strips where uneven transitions between 6 mm and 13 mm occur.
- .15 Install prefabricated control and movement joints in tile Work in accordance with detail 301MJ from TTMAC Installation Manual to suit installation indicated.

- .16 Do not saw-cut joints after installing tiles:
 - .1 Locate joints in tile surfaces directly above joints in concrete substrates.
 - .2 Provide floor control joints over structural control joints.
 - .3 Install prefabricated joint profiles in accordance with manufacturer's written instructions, set with top surface of joint profile slightly below top surface of tile.
 - .4 Prepare joints and apply sealants in accordance with requirements of Section 07 92 00.
 - .5 Keep control and movement joints free from setting materials.
 - .17 Form an open joint for sealant in tile Work wherever a change in the backing wall material occurs, at all vertical interior corners, around penetrating pipes and fixtures, and where tile abuts other materials or fixtures.
- 3.5 Grout
- .1 Site Applied Temporary Protective Coating: Protect exposed surfaces of tile against adherence of mortar and grout by pre-coating them with a continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces where required by tile manufacturer to prevent adhesion or staining of exposed tile surfaces by grout:
 - .1 Petroleum paraffin wax, applied hot.
 - .2 Grout release.
 - .3 Petroleum paraffin wax or grout release.
 - .2 Install grout in accordance with manufacturer's written instructions, the requirements of the Terrazzo, Tile and Marble Association of Canada (TTMAC), and as follows:
 - .1 Allow proper setting time before application of grout.
 - .2 Force grout into joints to a smooth, dense finish.
 - .3 Remove excess grout in accordance with manufacturer's written instructions and polish tile with clean cloths.
 - .3 Install chemical-resistant epoxy grouts in accordance with ANSI A108.1; clean from tile surfaces as work proceeds in accordance with manufacturer's written instructions using clean water.
- 3.6 Adjusting
- .1 Upon completion of the Work repair surfaces that have been permanently stained, marred, or otherwise damaged. Replace tiles which are damaged or cannot be adequately cleaned as directed.
- 3.7 Cleaning
- .1 Upon completion of the Work, remove unused materials, debris, containers and equipment from the project site. In addition to the initial cleaning procedure required, clean the tile Work not more than 2 days before occupancy or acceptance by the Owner.
- 3.8 Protection
- .1 Protect tile Work during the construction period so that it will be without any indication of use or damage at the time of acceptance.

3.9 Installation Schedule

- .1 Install tile Over Masonry or Concrete Walls – Thin-Set Method to TTMAC details 303W.
- .2 Install tile Over Gypsum Board – Thin-Set Method Dry Areas Only to TTMAC Details 304W
- .3 Install Large Format Tiles on Interior Walls to TTMAC detail 330LFT.

END OF SECTION

1 GENERAL

1.1 Summary

- .1 Provide acoustic panel ceilings in accordance with requirements of the Contract Documents.

1.2 References

- .1 Acoustic Materials Association (AMA):

.1 AMA-1, Ceiling Sound Transmission Test by the Two-Room Method.

- .2 ASTM International (ASTM):

.1 ASTM A580/A580M, Standard Specification for Stainless Steel Wire

.2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.3 ASTM C635/C635M, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

.4 ASTM C636/C636M, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

.5 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.6 ASTM E1264, Standard Classification for Acoustical Ceiling Products.

- .3 Ceilings and Interior Systems Construction Association (CISCA):

.1 CISCA Ceiling Systems Handbook

- .4 Underwriters Laboratories of Canada (ULC):

.1 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 Administrative Requirements

- .1 Coordination: Coordinate layout and installation of acoustic panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire suppression system, and partition assemblies, and as follows:

.1 Schedule and coordinate installation of ceiling to occur subsequent to completion of overhead mechanical and electrical work.

.2 Schedule and coordinate ceiling installation with mechanical and electrical trades building in components into ceiling finish panels.

1.4 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.

- .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings for the fabrication and installation of the Work. Show typical details of the conditions for each type of acoustical ceiling, joint, anchorage and support in the system. Include reflected ceiling plans, and items which are to be coordinated with the acoustical ceiling system.

- .3 Samples: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for colour and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Furnish samples of each type and colour of ceiling panel or tile in not less than 150 x 150 mm size. Furnish samples of exposed grid system components in 300 mm lengths and required finish.

1.5 Quality Assurance

- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- .2 Field Samples: Prior to the Pre-construction Conference, provide a field sample for each type acoustical ceiling in the building at areas to be designated by the Consultant. Utilize the same materials and installation methods in the sample as required for the final Work. Schedule the installation so that the sample may be examined, and any necessary adjustments made, at least 1 week prior to date scheduled for commencing installation of the Work. When accepted, sample areas shall serve as the standard for materials, workmanship, and appearance for such Work throughout the project and shall remain a part of the final Work.
- .3 Regulatory Requirements: Provide acoustic panel ceilings that meet requirements of ASTM E84 and ULC S102; labelled and listed by Underwriters Laboratories Inc. (UL), Underwriters Laboratories of Canada (ULC) or Warnock Hersey-Intertek (WHI), or another testing and inspecting agency acceptable to Authorities Having Jurisdiction in accordance with Section 07 05 80.

1.6 Project Closeout Submissions

- .1 Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in the operations manual; provide specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.
- .2 Spare Parts: Extra Acoustical Materials: Furnish extra stock of each type acoustical tile and panel in a quantity equal to 1% of the amount installed in the Work, but not less than 1 standard carton. Deliver to the Owner and store at the project site where directed.

1.7 Delivery, Storage and Handling

- .1 Delivery and Acceptance Requirements: Deliver acoustic panels and suspension system components to Project site in original, unopened packages and store in a fully enclosed space, protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- .2 Storage and Handling Requirements: Permit acoustic panels to reach room temperature and stabilized moisture content before installing; handle acoustic panels to avoid chipping edges or damaging units; replace damaged units as directed by Consultant.

1.8 Site Conditions

- .1 Ambient Conditions: Install acoustic unit ceilings only when building is enclosed, has sufficient heat, when overhead mechanical and electrical work is complete, and dust and moisture producing activities are complete; maintain uniform temperatures and relative humidity within range recommended by material manufacturer from the time of installation until Substantial Performance for the project; make adjustments to temperature and humidity gradually within tolerances indicated by manufacturer.

2. PRODUCTS

2.1 Manufacturers

- .1 Acceptable Materials Manufacturers: Subject to compliance with requirements specified in this Section, manufacturers offering products that may be incorporated into the Work include the following:

- .1 Acoustic Panels Suspended Systems:
 - .1 Armstrong World Industries Canada Ltd.
 - .2 CertainTeed
 - .3 CGC Interiors, a USG Company
 - .4 Rockfon

2.2 Design Criteria

- .1 Superimposed Loads: Determine superimposed loads applied to suspension systems by components of the building and verify that adequate hangers are installed to support additional loads in conjunction with normal loads of the ceiling system, and as follows:
 - .1 Maximum Deflection: Limit deflection to L/360 in accordance with ASTM C635 deflection test.
 - .2 Seismic Restraints: Design system to withstand seismic forces outlined in Building Code for normal facilities, based on a full uniform ceiling load acceleration of 0.246 g and velocity of 0.133 m/s in accordance with ASTM A580; ceilings areas less than 13 m² and surrounded by walls connected to structure above do not require seismic restraints.

2.3 Materials

- .1 Acoustic Panels: Provide manufacturer's standard metric panels of configuration indicated in accordance with ASTM E1264 classifications as designated by the nominal values for types, patterns, acoustic ratings, and light reflectance class listed in this Section; with flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with CAN/ULC S102 and as follows:
 - .1 Acoustic Panel Ceiling (ACT-1):
 - .1 Physical Properties: Type: IV, Form 2, Pattern E
 - .2 Dimensions: 610 mm x 1220 mm x 25 mm
 - .3 Edge Profile: square lay-in
 - .4 Colour: White
 - .5 Acoustic and Visual Performance (Minimum Nominal):
 - NRC: 0.85
 - LR: 0.88
 - .6 Basis-of-Design: Armstrong Ultima high NRC, 2083
 - .2 Acoustic Panel Ceiling (ACT-2):
 - .1 Physical Properties: Type: IV, Form 1 and 2, Pattern E, G
 - .2 Dimensions: 610 mm x 1220 mm x 22 mm
 - .3 Edge Profile: square
 - .4 Colour: White
 - .5 Acoustic and Visual Performance (Minimum Nominal):
 - NRC: 0.85
 - LR: 0.90
 - .6 Basis-of-Design: CGC Mars Healthcare 88256
- .2 Acoustic Panel Ceiling (ACT-3): refer to Section 09 51 26.
- .3 Metal Suspension System – Acoustical Panel Ceilings: Manufacturer's standard direct hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C635 requirements and as supplied by same materials supplier as acoustic panels for intermediate duty, exposed tee bar.
 - .1 Tee Bar Grid Face Width: as appropriate for materials specified.
 - .2 Hangers, Braces and Ties: Nominal 1.98 mm (14 ga.) Ø steel wire, galvanized
 - .3 Exposed Finish: Manufacturer's standard satin, white finish
 - .4 Corrosion Resistance: Hot-dip galvanized or stainless steel components.

- .5 Acceptable materials: materials to match products specified, use only materials from same manufacturers of panel products.
- .4 Attachment Devices: Size for five (5) times design load indicated in ASTM C635, Table 1, Direct Hung, having corrosion protection for mild service conditions, and as follows:
 - .1 Concrete Anchors: Anchors of type to option of Contractor, with holes or loops for attaching hangers having capacity to sustain ceiling loads as indicated in above, selected from one of the following types:
 - .1 Cast-in-place anchors
 - .2 Post Installed expansion anchors
 - .3 Chemical anchors
 - .4 Powder actuated fasteners, except that design load is sized for ten (10) times that indicated above.
 - .2 Rod and Flat Hangers: Mild steel, zinc coated.
 - .3 Angle Hangers: Minimum 22 mm x 22 mm x 1 mm thick angles, Z275 (G90) galvanized steel sheet in accordance with ASTM A653/A653M; bolted connections using 8 mm Ø bolts.
- .5 Edge Mouldings and Trim: Sheet metal edge mouldings and trim selected from manufacturer's standard mouldings for edges and penetrations that fit specified acoustic panel edge and suspension system, and as follows:
 - .1 Provide edge mouldings and trims that match width and configuration of exposed runners including the following configurations:
 - .1 Sheet Metal Fillers: Light zinc coated sheet steel finished to match T-bar
 - .2 Shadow Mould: Rolled sheet metal, one piece, having 19 mm x 13 mm flange and reveal
 - .3 Wall Mould: Channel or angle shape with a 25 mm exposed face

2.4 Edge Trim

- .1 Profiled Edge Mouldings and Trim: Manufacturer's standard extruded aluminum or cold rolled steel edge mouldings and trims, including splice plates, corner pieces, gypsum board trim, attachments and other clips, and as follows:
 - .1 Size: nominal 150 mm high
 - .2 Profile: Curved, as detailed
 - .3 Exposed Finish: Manufacturer's standard satin, white finish
 - .4 Acceptable materials:
 - .1 Armstrong Axiom
 - .2 CertainTeed Cloud Perimeter Trim
 - .3 CGC Compásso
 - .4 Rockfon Infinity

3. EXECUTION

3.1 Examination

- .1 Verification of Conditions: Verify that substrates and structural framing are in accordance with manufacturer's requirements specified in this and other Sections that affect ceiling installation, anchorage, and other conditions affecting performance of acoustic panel ceilings.
 - .1 Installation of ceiling system indicates denotes acceptance of site conditions.

3.2 Preparation

- .1 Measure each ceiling area and establish layout of acoustic panels to balance border widths at opposite edges of each ceiling:
 - .1 Install acoustic panel ceilings in accordance with layout indicated on reflected ceiling plans
 - .2 Layout acoustic panel ceilings to avoid use of panels less than half the width of full sized panels at borders

3.3 Installation

- .1 Install acoustic panel ceilings in accordance with manufacturers written instructions and as follows:
 - .1 Install ceiling suspension system in accordance with ASTM C636/C636M.
 - .2 Suspend ceiling hangers from building's structural members and as follows:
 - .1 Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system:
 - .1 Do not support ceilings directly from permanent metal forms, floor deck or other non-structural framing.
 - .2 Do not attach hangers to steel deck tabs.
 - .3 Do not attach hangers to steel roof deck.
 - .4 Attach hangers to structural members or intermediate supports.
 - .2 Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other means that does not create a kink in the suspension wires
 - .3 Install supplemental suspension members and hangers in form of trapezes or similar devices where width of ducts and other construction within ceiling plenum produces hanger spacing that interferes with location of hangers at required spacing to support standard suspension system members:
 - .1 Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications
 - .4 Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns
 - .5 Connect hangers directly to structure or to flat, angle, channel or rods securely fastened to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are:
 - .1 Secure
 - .2 Appropriate for substrate
 - .3 Will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures
 - .6 Space hangers at 1220 mm maximum along each member supported directly from hangers, and provide hangers not more than 200 mm from ends of each member.
 - .7 Provide additional hangers where lay-in electrical or mechanical fixtures are installed in suspension system; one at each corner with stabilizer bars to prevent overloading or rotation of the suspension members where required.
 - .8 Do not level ceilings by putting kinks in the suspension wires.
 - .2
 - .3 Install edge mouldings and trim of type indicated at perimeter of acoustic ceiling area and where necessary to conceal edges of acoustic panels.
 - .1 Fasten mouldings to substrate at 406 mm O/C, not more than 75 mm from ends, levelling with ceiling suspension system to a tolerance of 3 mm in 3600 mm.
 - .2 Mitre corners accurately and connect securely.
 - .3 Do not use exposed fasteners, including pop rivets, on mouldings and trim, unless specifically allowed by the Consultant.

- .4 Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
 - .5 Accurately fit and install acoustic panels into suspension system runners and edge mouldings; scribe and cut panels at borders and penetrations to provide a neat, precise fit; replace damaged panels at no expense to the Owner.
 - .6 Arrange directionally patterned acoustic panels as follows:
 - .1 As indicated on reflected ceiling plans.
 - .7 Install acoustic panels as follows:
 - .1 Square Edged Panels: Install panels with edges fully hidden from view by flanges of suspension system runners and mouldings; use sheet metal filler coloured to match suspension system where any face dimension of a piece of acoustic panel, measured from centre of Tee to face of wall or column is less than 75 mm.
 - .2 Protect lighting fixtures and air ducts in accordance with requirements indicated for fire resistance rated assembly.
- 3.4 Closeout Activities
- .1 Cleaning: Clean exposed surfaces of acoustic panel ceilings, including trim, edge mouldings, and suspension system members in accordance with manufacturer's instructions.
 - .2 Repairs: Touch-up minor damage to finishes in accordance with manufacturer's instructions; remove and replace ceiling components that cannot be successfully cleaned and repaired.

END OF SECTION

1. GENERAL

1.1 Summary

.1 This Section includes requirements for supply and installation of acoustical wood plank systems into a suspended ceiling grid for interior installations.

.2 Indicated as ACT-3.

1.2 References

.1 American National Standards Institute (ANSI):

.1 NPA A208.2-2009, Medium Density Fiberboard (MDF) for Interior Applications

.2 ASTM International (ASTM):

.1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

.2 ASTM C635/C635M, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustic Tile and Lay-in Panel Ceilings

.3 ASTM C636/C636M, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustic Tile and Lay-In Panels

.4 ASTM E580/E580M, Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions

.3 Canadian Hardwood Plywood & Veneer Association (CHPVA):

.1 CHPVA Official Grading Rules for Canadian Hardwood Plywood.

.2 CHPVA Official Grading Rules for Rotary Cut Birch, Oak and Maple Veneers .

.4 Ceilings & Interior Systems Construction Association (CISCA):

.1 CISCA Ceiling Systems Handbook.

.5 Hardwood Plywood and Veneer Association (HPVA):

.1 Hardwood Plywood Reference Guide and Sales Handbook

.6 Underwriters Laboratories Canada (ULC):

.1 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

1.3 Administrative Requirements

.1 Coordination: Coordinate layout and installation of acoustic wood ceiling and suspension system with other construction that penetrates ceilings or is supported by them including; but not limited to, light fixtures, HVAC equipment, fire suppression system, and partition assemblies, and as follows:

.1 Schedule and coordinate installation of ceiling to occur after completion of overhead mechanical and electrical work.

.2 Schedule and coordinate ceiling installation with mechanical and electrical trades building in components into ceiling finish panels.

.2 Pre-Installation Conference: Conduct conference at Project site in accordance with requirements of Section 01 00 10 – Site Meetings to discuss coordination issues with Construction Manager, Subcontractor and Consultant present.

1.4 Submittals

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
 - .1 Product Data: Submit product data for each system specified for review by consultant including product test reports indicating compliance with specified acoustical performance requirements [and meeting fire resistance requirements listed in this Section].
 - .2 Samples: Submit [two (2)] sets of samples to Consultant for verification of materials supplied to the project in sets for each colour, texture, and pattern specified, showing full range of expected variations expected as follows:
 - .1 200 mm x 275 mm] [Full size] samples of each acoustic panel type, pattern, and colour.
 - .2 Set of 300 mm long samples of exposed suspension system members, including mouldings, for each colour and system type required.
- .2 Informational Submittals: Provide the following submittals during the course of the work:
 - .1 Coordination Drawings: Submit coordination drawings including reflected ceiling plans drawn to scale and coordinating penetrations and ceiling mounted items indicating the following:
 - .1 Ceiling suspension system members
 - .2 Method of attaching suspension system hangers to building structure
 - .3 Ceiling mounted items including light fixtures; air outlets and inlets; speakers; sprinklers; and special mouldings at walls, column penetrations, and other junctures of acoustic ceilings with adjoining construction
 - .4 Minimum Drawing Scale: 1 to 50
 - .2 Source Quality Control Testing: Submit fastener test results indicating that fasteners and anchors used to suspend the ceiling system have a minimum capacity of 890 N in tension and that anchors used to attach bracing wires have a minimum capacity of 1960 N in tension.
 - .3 Certificates: Submit written certification after completion of project for each product specified indicating compliance with acoustical and fire performance requirements signed by the panel manufacturer, and that materials supplied as components meet or exceed the specified requirements.

1.5 Project Closeout Submissions

- .1 Provide operations and maintenance information in accordance with Section 01 00 10 – General Requirements:
 - .1 Submit specific maintenance practices indicating any materials that may damage or disfigure the finished Work.

1.6 Quality Assurance

- .1 Regulatory Requirements: Provide acoustical wood ceilings meeting flame spread and smoke developed requirements in accordance with ULC S102.
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
 - .1 Installers: Use installers having proven experience in completing acoustical wood ceilings having similar material, design, and complexity as that required for this project and having a record of successful in-service performance for the previous two (2) years.
 - .2 Manufacturers: Obtain materials from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties.

1.7 Delivery, Storage and Handling

- .1 Delivery and Acceptance Requirements: Deliver acoustical wood ceiling components to site in original, unopened packages and store in fully enclosed space, protected against damage from moisture, direct sunlight, surface contamination, and other causes, and when temperature and humidity of installation and storage areas approximate conditions that will exist when building is occupied.
- .2 Storage and Handling Requirements: Allow acoustic wood ceiling components to reach room temperature and stabilized moisture content before installing; handle acoustic wood ceiling components to avoid chipping edges or damaging units in any way; replace damaged units when directed by Consultant.

1.8 Site Conditions

- .1 Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on shop drawings where acoustical wood ceilings are indicated to fit between walls and other construction; coordinate fabrication schedule with construction progress to avoid delaying the Work.
- .2 Established Dimensions: Establish dimensions and proceed with fabricating acoustical wood ceilings without site measurements where site measurements cannot be made without delaying the Work; coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for trimming and fitting.
- .3 Environmental Requirements: Perform installation when heating and cooling systems are operational, and temperature and humidity closely approximate the interior operating conditions required for the final construction; allow wood materials to acclimate and stabilize to site conditions a minimum of 72 hours before installation when site is free of wet and dusty work, and above ceiling work is complete.

2. PRODUCTS

2.1 Performance Requirements

- .1 Determine the superimposed loads that will be applied to suspension systems by components of the building other than the ceiling and ensure that adequate hangers are installed to support the additional loads (light fixtures, mechanical ducts and similar items) as well as loads of the ceiling system itself to limit deflection to 1/360th of the span in accordance with ASTM C635.
- .2 Manufacture and install components to provide minimum Noise Reduction Coefficient (NRC) listed for specified products; test in accordance with ASTM C423.
- .3 Limit flame spread rating of materials supplied to the project and that are used in exits to 25 or less, with smoke developed at 450 or less when tested in accordance with CAN/ULC S102.
- .4 Design system to withstand seismic forces outlined in Building Code for post disaster facilities, based on a full uniform ceiling load acceleration of 0.246 g and velocity of 0.133 m/s in accordance with ASTM E580:
 - .1 Ceilings having an area of 13.4 m² (144 ft²) or less and surrounded by walls connected to structure above are excluded from Seismic Restraint Requirements of ASTM E580.

2.2 Materials

- .1 Ceiling Panels Type ACT-3
 - .1 Surface Texture: Smooth
 - .2 Composition: Fire-retardant Particle Board

- .3 Species/Finish: Natural Variations Oak
 - .4 Size: 3-3/4" x 96"
 - .5 Reveal: Plank - 3/4" Reveal
 - .6 Profile:
 - .7 Sabin:N/A
 - .8 Edge Banding and Trim: To match face veneer
 - .9 Noise Reduction Coefficient (NRC):
 - .10 Flame Spread: ASTM E84 HPVA Fire Classification (Fire Class)
 - .11 Dimensional Stability: Standard
- .2 Basis-of-Design: WOODWORKS Linear Veneered Planks, Item # 6440W1 as manufactured by Armstrong World Industries
- .3 Ceiling Accessories (Ceilings) WoodWorks: 5823 - BioAcoustic Infill Panel (Black - Matte)
- 2.3 Accessories
- .1 Provide two layers of black infill panel mesh or screen to areas indicated, as recommended by ceiling manufacturer.
- 2.4 Profile edge Mouldings
- .1 Profiled Edge Mouldings and Trim: Manufacturer's standard extruded aluminum or cold rolled steel edge mouldings and trims, including splice plates, corner pieces, [gypsum board trim], attachments and other clips, and as follows:
- .1 Size: nominal as indicated in Section 09 06 06
 - .2 Profile: Flat
 - .3 Exposed Finish: Custom colour selected from manufacturer's extended range]
 - .4 Acceptable materials:
 - .1 Armstrong Axiom
 - .2 CertainTeed Cloud Perimeter Trim
 - .3 CGC Compasso
 - .4 Rockfon Infinity Trim
- 3. EXECUTION**
- 3.1 Examination
- .1 Examine substrates and structural framing for compliance with requirements specified in this and other Sections that affect ceiling installation, anchorage, and other conditions affecting performance of acoustical wood ceilings.
- .2 Installation of ceiling system indicates acceptance of conditions.
- 3.2 Preparation
- .1 Measure each ceiling area and establish layout of wood panels to balance border widths at opposite edges of each ceiling:
- .1 Install acoustical wood ceilings in accordance with layout indicated on reflected ceiling plans.
 - .2 Avoid using panels less than ½ width at borders.

3.3 Installation

- .1 Install acoustical wood ceilings in accordance with manufacturers written instructions and as follows:
 - .1 Install ceiling suspension system in accordance with ASTM C636.
 - .2 Install ceiling suspension systems requiring seismic restraint in accordance with ASTM E580.
- .2 Suspend ceiling hangers from building's structural members, and as follows:
 - .1 Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - .2 Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter splaying, or other means that prevents creating kinks in the suspension wires.
 - .3 Install supplemental suspension members and hangers, trapezes or similar devices where width of ducts and other construction within ceiling plenum produces hanger spacing that interferes with location of hangers at required spacing to support manufacturer's suspension system; size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 - .4 Secure wire hangers to ceiling suspension members and to supports above using a minimum of three tight turns.
 - .5 Connect hangers directly to structure or to flat, angle, channel or rods securely fastened to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are:
 - .1 Secure.
 - .2 Appropriate for substrate.
 - .3 Will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - .6 Attach hangers to structural members or intermediate supports:
 - .1 Do not support ceilings directly from permanent metal forms or floor deck.
 - .2 Do not attach hangers to steel deck tabs.
 - .3 Do not attach hangers to steel roof deck.
 - .7 Space hangers at 1220 mm maximum along each member supported directly from hangers, and provide hangers not more than 200 mm from ends of each member.
 - .8 Provide additional hangers where there are lay-in electrical or mechanical fixtures, one at each corner and; if required, stabilizer bars to prevent overloading or rotation of suspension members.
 - .9 Level ceilings by adjusting length of suspension wires; do not level ceilings by putting kinks in the suspension wires.
- .3 Edge moulding and trim installation: refer to Drawings.
- .4 Install expansion joints to locations indicated on Drawings, and as follows:
 - .1 Create expansion joint using manufacturer's standard materials, 25 mm apart, on building expansion joint line.
 - .2 Secure continuous strip of sheet steel angle; painted black, to one side of expansion joint.
 - .3 Make exposed angle leg 25% narrower than tight fit.
- .5 Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

- .6 Accurately fit and install wood panels into suspension system runners and edge mouldings:
 - .1 Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - .2 Damaged panels will not be acceptable, and shall be replaced.

- 3.4 Cleaning
 - .1 Clean exposed surfaces of suspended unit ceilings, including trim, edge mouldings, and suspension system members.
 - .2 Comply with manufacturer's written instructions for cleaning and touch-up of minor finish damage.
 - .3 Remove and replace ceiling components that cannot be successfully cleaned and repaired.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide acoustic ceiling baffles in accordance with requirements of the Contract Documents.
- .2 Indicated as ACP in Section 09 06 06.

1.2 References

- .1 ASTM International (ASTM):
 - .1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 - .2 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 - .3 ASTM D1117, Standard Guide for Evaluating Nonwoven Fabrics (withdrawn)
 - .4 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 51.10, Mineral Fibre Board Thermal Insulation
- .3 CSA Group (CSA):
 - .1 CSA/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

1.3 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
- .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings for the fabrication and installation of the Work. Show typical details of the conditions for each type, joint, anchorage and support in the system. Include reflected ceiling plans, and items which are to be coordinated with the acoustical ceiling system.
- .3 Samples: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for colour and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Furnish samples of each type and colour in not less than 150 x 150 mm size.

1.4 Quality Assurance

- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- .2 Field Samples: Prior to the Pre-construction Conference, provide a field sample for each type acoustical ceiling in the building at areas to be designated by the Consultant. Utilize the same materials and installation methods in the sample as required for the final Work. Schedule the installation so that the sample may be examined, and any necessary adjustments made, at least 1 week prior to date scheduled for commencing installation of the Work. When accepted, sample areas shall serve as the standard for materials, workmanship, and appearance for such Work throughout the project and shall remain a part of the final Work.

- .3 Regulatory Requirements: Provide acoustic panel ceilings that meet requirements of ASTM E84 and ULC S102; labelled and listed by Underwriters Laboratories Inc. (UL), Underwriters Laboratories of Canada (ULC) or Warnock Hersey-Intertek (WHI), or another testing and inspecting agency acceptable to Authorities Having Jurisdiction in accordance with Section 07 05 80.

1.5 Project Closeout Submissions

- .1 Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in the operations manual; provide specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.
- .2 Spare Parts: Extra Acoustical Materials: Furnish extra stock of each type acoustical panel in a quantity equal to 1% of the amount installed in the Work. Deliver to the Owner and store at the project site where directed.

1.6 Delivery, Storage and Handling

- .1 Delivery and Acceptance Requirements: Deliver system components to Project site in original, unopened packages and store in a fully enclosed space, protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- .2 Storage and Handling Requirements: Permit system components to reach room temperature and stabilized moisture content before installing; handle system components to avoid damaging units; replace damaged units as directed by Consultant.

1.7 Site Conditions

- .1 Ambient Conditions: Install system components only when building is enclosed, has sufficient heat, when overhead mechanical and electrical work is complete, and dust and moisture producing activities are complete; maintain uniform temperatures and relative humidity within range recommended by material manufacturer from the time of installation until Substantial Performance for the project; make adjustments to temperature and humidity gradually within tolerances indicated by manufacturer.

2. PRODUCTS

2.1 Materials

- .1 ACP-1
 - .1 Manufacturer: Armstrong
 - .2 Type: Soundscape Blades
 - .3 Type Number: 3920
 - .4 Size: 190 x 1168 x 50 mm
 - .5 Colour: White
 - .6 Suspension system: Individual Suspension using hanging kit 6655
- .2 ACP-2
 - .1 Manufacturer: Armstrong
 - .2 Type: Soundscape Blades
 - .3 Type Number: 3920
 - .4 Size: 190 x 1168 x 50 mm
 - .5 Colour: Black
 - .6 Suspension system: Individual Suspension using hanging kit 6655
- .3 ACP-3
 - .1 Manufacturer: Armstrong

- .2 Type: Soundscape Blades
 - .3 Type Number: 3920
 - .4 Size: 190 x 1168 x 50
 - .5 Colour: Custom Red
 - .6 Suspension system: Individual Suspension using hanging kit 6655
- .4 ACP-4
- .1 Manufacturer: Armstrong
 - .2 Type: Soundscape Blades
 - .3 Type Number: 3920
 - .4 Size: 190 x 1168 x 50 mm
 - .5 Colour: Custom Yellow
 - .6 Suspension system: Individual Suspension using hanging kit 6655
- .5 ACP-5
- .1 Manufacturer: Acoufelt
 - .2 Type: Curve ½"
 - .3 Size: 254 x 1220 x 12 mm
 - .4 Colour: Grey
 - .5 Suspension system: Cable to Deck
- .6 ACP-6
- .1 Manufacturer: Turf
 - .2 Type: Freedom Ceiling Baffle
 - .3 Size: Depth 190 mm; Thickness 50 mm
 - .4 Colour: 01 Cream
 - .5 Suspension system: Cable to Deck
- .7 Suspension: Cable to deck system kit – refer to Section 09 06 06 and as detailed on Drawings.

2.2 Fabrication

- .1 Fabricate baffles without distortion and construct seams to provide symmetrical appearance and smooth, flat faces and edges.
- .2 Centre hanger fasteners on width of top edges. Provide concealed anchorage using sheet metal secured to chemically hardened core edges.
- .3 Tolerances:
 - .1 Face Squareness: 3 mm maximum variation in diagonal dimensions across baffle faces.
 - .2 Face Warpage: 3 mm maximum measured across face diagonals.
- .4 Where frame is wood, plastic or metal, provide one piece frame along top of baffles and frame split mid-width at exposed baffle edges.
- .5 Where ends are split-framed, conceal fabric edges by back-wrapping and adhering fabric to back of split framing.

2.3 Accessories

- .1 Adhesive: water-resistant, clear-drying and compatible with contacting materials.
- .2 Sewing Thread: material and colour; clear or matching fabric.

2.4 Suspension System Components

- .1 Metal Components: stainless steel.
- .2 Hangers: metal cables, minimum 1.6 mm diameter.
- .3 Hanger Fasteners: designed to prevent accidental separation, and as follows:
 - .1 To Baffles: metal.
 - .2 To Structure: metal, threaded or expansion type. Driven type fasteners not permitted.
- .4 Fastener Anchorage at Baffles: into framing, or metal plate anchored to core where core edges are chemically hardened, to suit design criteria.

3. EXECUTION

3.1 Verification of Conditions

- .1 Do not begin installation until:
 - .1 Dust generating activities are completed.
 - .2 Other overhead work has been completed.
- .2 Verify the following:
 - .1 Substrate for hanger anchorage is structurally adequate.
 - .2 Existing conditions conform with drawings.
 - .3 Baffles will not interfere with air supply, lighting, sprinkler and sound reinforcement system operation.
- .3 Report nonconforming conditions to Consultant before beginning installation.

3.2 Installation

- .1 Secure hanger fasteners to structure as indicated on drawings to meet design criteria.
- .2 Locate and align baffles as indicated on drawings. Hang baffles as indicated on drawings.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide floor repair and levelling in accordance with requirements of Contract Documents.
- .2 Include supply and installation of "Standard" floor repair as noted in the Contract Documents. Include in base bid floor repair for core fills, floating of floors, sloping to drains etc.
- .3 Floor repair, levelling and surface preparation is the responsibility of the General Contractor or floor repair / levelling subtrade. Coordinate with floor installers.

1.2 Floor Repair Intent

- .1 Remove residue, previous surface treatments, including any adhesives, from slabs prior to installation of topping, or new floor finish by sanding using a floor sanding machine.
- .2 Apply skim coat or leveling and sand to ensure a smooth substrate for new flooring. In particular, ensure there are no ridges which will telegraph through new flooring. Vacuum and remove all debris from preparation process.
- .3 Plug existing core holes in existing slabs with non-shrink cement grout as required.
- .4 Slope to drains and form other transitions as noted on the drawings.
- .5 Removal of existing flooring residue, including flooring material and adhesives which requires scraping and track blasting (shot blasting) or grinding as confirmed by the Consultant.
- .6 Application of self-leveling underlayment as directed by the Consultant.

1.3 References

- .1 American Concrete Institute (ACI):
 - .1 ACI 117, Specification for Tolerances for concrete Construction and Materials and Commentary
 - .2 ACI 302, Guide for Concrete Floor Slab and Construction
- .2 American National Standards Institute (ANSI):
 - .1 ANSI 108.1, General Requirements: Subsurfaces and Preparations by Other Trades
- .3 ASTM International (ASTM):
 - .1 ASTM C349, Standard Test Method for Compressive Strength of Hydraulic-Cement Mortars (Using Portions of Prisms Broken in Flexure)
 - .2 ASTM C627, Standard Test Method for Evaluating Ceramic Floor Tile Installation Systems Using the Robinson-Type Floor Tester
 - .3 ASTM E1155, Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
 - .4 ASTM F710, Standard Practice for Preparing Concrete Floor to receive Resilient Flooring
 - .5 ASTM F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
 - .6 ASTM F2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

- .4 Canadian General Standards Board (CGSB):
 - .1 CGSB 71-GP-30M, Adhesive, Epoxy and Modified Mortar Systems, for Installation of Quarry Tiles (withdrawn)

1.4 Quality Assurance

- .1 Work that is judged by the Consultant to be below an acceptable standard is to be demolished, removed and rebuilt as directed by the Consultant.

2. PRODUCTS

- .1 New ANSI A118.16 for levelers. Cement based levelers. Trowellable Levelling and Patching Compounds: Latex modified, portland cement based formulation provided or approved by resilient product manufacturer for applications indicated; Gypsum based materials will not be accepted for use on this project.

2.2 Materials

- .1 Skim coating: cementitious based, gypsum based products are NOT acceptable. Acceptable Materials:
 - .1 ARDEX Feather Finish
 - .2 CustomTech Silk Patching & Finishing Component
 - .3 TEC Perfect Finish
 - .4 UZIN NC 150
- .2 Feather edging: polymer-modified, cementitious, 2 component, fast setting, trowel applied. Acceptable Materials:
 - .1 ARDEX SD-P
 - .2 CustomTech TechPatch-MP Multipurpose RS Skim Coat & Floor Patch
 - .3 MAPEI Planitop 21
 - .4 SikaTop 121 Plus
 - .5 UZIN NC 170
- .3 Self-leveling and smoothing underlayment: Performance standard to ASTM C349 (and CGSB 71-GP-30M), Type 2, minimum compressive strength 30 MPa (4400 psi) after 28 days. Acceptable Materials:
 - .1 Ardex K-15.
 - .2 CustomTech TechLevel 150 Self Leveling Underlayment
 - .3 Geistlich International, Inc. - "Teck 2800".
 - .4 Mapei Canada - "Ultra/Plan".
 - .5 Target Products, "Floor Leveller C26 UL".
 - .6 Thoro Products, "Thoro Underlayment".
 - .7 UZIN NC 170
- .4 Grout for filling core holes: Acceptable Materials:
 - .1 CG-86 Construction Grout by WR Meadows.
 - .2 Custom Building Products SpeedSlope RS Sloping Mortar
 - .3 MAPEI Planigrout 712
 - .4 Sika Grout 212 by Sika Canada.
 - .5 UZIN NC 182
- .5 Self-leveling and smoothing underlayment: Performance standard to ASTM C349 (and CGSB 71-GP-30M), Type 2, minimum compressive strength 30 MPa (4400 psi) after 28 days.
 - .1 Ardex K-15.
 - .2 CustomTech TechLevel 150 Self Leveling Underlayment

- .3 Mapei Canada - "Ultra/Plan 1 Plus.
- .4 SIKA Canada Sikafloor Level 125 CA
- .5 WR Meadows, Sure-Flo FT 100.
- .6 UZIN NC 150

3. EXECUTION

3.1 Floor Preparation

- .1 Remove existing flooring as applicable.
- .2 Sand floor using power floor sanding machine. Vacuum up residue from preparation.
- .3 Apply primer to all gypsum based surfaces and other surfaces as recommended by skim coat manufacturer.
- .4 Trowel apply skim coat.
- .5 Sand skim coat to ensure there are no ridges or trowel marks or other imperfections which could telegraph through applied flooring. Vacuum residue from preparation.
- .6 Fill minor imperfections using skim coating material in accordance with manufacturer's installation instructions.
- .7 Use feather edging compound to make transitions of 19 mm or less in floor levels. Install specified product in accordance with manufacturer's installation instructions.
- .8 Chip floor as noted on the drawings. Clean floor of all residue and loose material. Prime floor. Apply primer in compliance with manufacturer's application instructions. Install topping to achieve floor slopes and finishes noted on the drawings. Comply with manufacturer's installation instructions.
- .9 Patch all core holes using specified grout.
- .10 Ensure any residue on slabs has been removed by track blast (shot-blast) treatment or grinding.
- .11 Prepare substrate including priming and constructing dams and apply self-leveling underlayment.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide Resilient Flooring and Accessories in accordance with requirements of Contract Documents.

1.2 References

- .1 American Association of Textile Chemists and Colorists
- .1 AATCC 134, Electrostatic Propensity of Carpets
- .2 ASTM International (ASTM):
- .1 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials
- .2 ASTM F150, Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring
- .3 ASTM F710, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- .4 ASTM F1066, Standard Specification for Vinyl Composition Floor Tile.
- .5 ASTM F1303, Standard Specification for Sheet Vinyl Floor Covering with Backing.
- .6 ASTM F1344, Standard Specification for Rubber Floor Tile
- .7 ASTM F1516, Standard Practice for Sealing Seams of Resilient Flooring Products by the Heat Weld Method (when Recommended).
- .8 ASTM F1700, Standard Specification for Solid Vinyl Floor Tile
- .9 ASTM F1859, Standard Specification for Rubber Sheet Floor Covering Without Backing
- .10 ASTM F1860, Standard Specification for Rubber Sheet Floor Covering With Backing
- .11 ASTM F1861, Standard Specification for Resilient Wall Base.
- .12 ASTM F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- .13 ASTM F1913, Standard Specification for Vinyl Sheet Floor Covering Without Backing
- .14 ASTM F2034, Standard Specification for Sheet Linoleum Floor Covering.
- .3 American National Standards Institute (ANSI):
- .1 ANSI/ESD S7.1, Resistive Characterization of Materials- Floor Materials
- .4 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB-51.34, Vapour Barrier, Polyethylene Sheet for Use in Building Construction
- .5 National Fire Protection Association (NFPA):
- .1 NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials (withdrawn).
- .6 Underwriters Laboratories of Canada (ULC):
- .1 CAN/ULC S102.2, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials

1.3 Administrative Requirements

.1 Coordination:

- .1 Coordinate floor flatness and levelling requirements of this section with requirements of Section 09 61 01; work of this Section includes floor levelling and patching required to meet resilient flooring manufacturer's installation requirements; notify Consultant where differences occur between specified tolerances and actual conditions.
- .2 Close spaces to traffic during flooring installation and until time period after installation recommended in writing by manufacturer.
- .3 Install flooring and accessories after other finishing operations, including painting and ceiling construction, have been completed.

1.4 Submittals

.1 Product Data: Submit for Consultant's action one copy of product data for each type of product specified.

.2 Samples for Verification: Submit for Consultant's action the following:

- .1 Resilient Flooring: Submit samples of each different specified product for verification of colour and pattern in manufacturer's standard size, but not less than 150 mm x 200 mm in size for tile or sheet material, or 150 mm long for resilient accessories.

.3 Site Quality Control Test Results: Submit for Consultant's action results or moisture emission testing of concrete subfloors prior to installation of flooring. Results shall include comparison of manufacturer's recommended moisture content to actual moisture vapour emission rate.

.4 Quality Assurance

.5 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.

.6 Field Samples: Prior to the Pre-construction Conference, provide a field sample for each type resilient flooring in the building at areas to be designated by the Consultant. Utilize the same materials and installation methods in the sample as required for the final Work. Schedule the installation so that the sample may be examined, and any necessary adjustments made, at least 1 week prior to date scheduled for commencing installation of the Work. When accepted, sample areas shall serve as the standard for materials, workmanship, and appearance for such Work throughout the project and shall remain a part of the final Work.

.7 Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of National, Provincial and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

.8 Qualifications: Provide proof of qualifications:

- .1 Resilient Flooring Installer: Use an installer who is competent in heat welding and have a minimum of five (5) years documented experience in the installation of resilient sheet flooring and seams in accordance with manufacturer's training or certification program:
- .2 Source Limitations: Obtain each type, colour, and pattern of flooring or accessories specified from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

1.5 Project Closeout Submissions

.1 Operation and Maintenance Data: Submit manufacturer's written instructions for maintenance and cleaning procedures, include list of manufacturer recommended cleaning and maintenance products, and name of original installer and contact information.

- .2 Extra Materials: Provide one unopened box of each colour of VCT used on project; packaged with protective covering for storage, and identified with labels describing contents.

1.6 Delivery, Storage, and Handling

- .1 Delivery and Acceptance Requirements: Deliver flooring and installation accessories to site in manufacturer's original, unopened cartons and containers, bearing names of product and manufacturer, project identification, and shipping and handling instructions.
- .2 Storage and Handling Requirements: Store products in dry spaces protected from the weather, with ambient conditions maintained between manufacturer's recommended temperature range, and as follows:
 - .1 Do not stack tile goods over four cartons high, and distribute cartons evenly over floor area to prevent overloading of structure.
 - .2 Keep water based adhesives from freezing.
 - .3 Store rolls upright in accordance with manufacturer's instructions.

1.7 Project Conditions

- .1 Ambient Conditions: Maintain air and substrate temperature of between 21°C and 30°C in spaces receiving resilient flooring for a minimum of 72 hours before installation, during installation, and 48 hours after installation, or longer as recommended by manufacturer's written instructions, and as follows:
 - .1 Move flooring and installation accessories into spaces where they will be installed a minimum of 72 hours before installation.
 - .2 Maintain a minimum temperature of 15°C after installation to prevent damage to flooring materials.
 - .3 Do not install flooring materials on substrates colder than ambient air temperature.
 - .4 Do not install flooring materials and accessories until they are at the same temperature as the space where they are installed.

2. PRODUCTS

2.1 Sheet Flooring

- .1 RSF-1 to RSF-15: Resilient Flooring:
 - .1 Thickness: 2.0 mm, unless noted otherwise
 - .2 Roll Width: Manufacturers standard width
 - .3 Refer to Section 09 06 06 for anti-static.
 - .4 Colour: Refer to Section 09 06 06

2.2 Resilient Accessories

- .1 RB-1: Resilient Wall Base: Smooth, buffed exposed face and ribbed or grooved bonding surface supplied in maximum practical length, conforming to ASTM F1861 and as follows:
 - .1 Type: TP – Thermoplastic Rubber
 - .2 Group: 1 – Homogeneous
 - .3 Style: A – Straight
 - .4 Height: 100 mm
 - .5 Thickness: 3 mm
 - .6 Colour: Refer to Section 09 06 06.
 - .7 Length: Manufacturers standard maximum length

- .2 Resilient Transition and Edge Strips: Refer to Section 09 06 06. Extruded vinyl shapes meeting or exceeding ADA Recommendations for change of level transitions for transition between floors finishes having different levels, i.e.: between resilient flooring on underlayment to carpet with no cushion or underlayment; acceptable materials as follows:
 - .1 Refer to Section 09 06 06 for Transitions: TS-2, TS-3.
 - .2 Coordinate with Section 09 30 00 for additional transition strips that may affect work of this section.
 - .3 Transition Leveller: Johnsonite LS-40 Leveller system – cut to length to suit height of lift required between dissimilar heights of floor finishes.
- 2.3 Installation Accessories
- .1 Trowellable Levelling and Patching Compounds: Latex modified, portland cement based formulation provided or approved by resilient product manufacturer for applications indicated; Gypsum based materials will not be accepted for use on this project.
 - .2 Adhesives: Solvent free, water resistant primer and adhesive as recommended by flooring or resilient accessory manufacturer to suit resilient products specified and substrate materials and conditions, and as follows:
 - .1 Flooring Adhesive: Light bodied adhesive recommended by flooring manufacturer
 - .2 Coved Flooring Base Adhesive: Heavy bodied adhesive recommended by flooring manufacturer.
 - .3 Rubber Base Adhesive: Contact adhesive recommended by base manufacturer.
 - .3 Heat Welding Bead: Solid strand product recommended by flooring manufacturer for heat welding seams, and as follows:
 - .1 Colour and Pattern: Match colour and pattern of resilient flooring, unless otherwise noted on Drawings.
 - .4 Polyethylene: 150 µm thickness conforming to CAN/CGSB-51.34.
 - .5 Tape: Self-adhesive 65 mm wide cloth tape.

3. EXECUTION

3.1 Examination

- .1 Testing and Inspections: Test moisture emission rate of concrete subfloor prior to installing flooring, using the calcium chloride test method in accordance with ASTM F1869 and ASTM F2170, and as follows:
 - .1 Provide 72 hours' notice to the Consultant of commencement of the Work
 - .2 Include cost of testing as a part of the price for work of this section.
 - .3 Do not install flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive, as determined by flooring manufacturer's recommended bond and moisture test, and as follows:
 - .1 Resilient flooring manufacturers generally set the maximum safe moisture emission level of concrete slabs at 0.170 µg/s.m²; confirm manufacturer's recommended emission rate before starting testing.
 - .2 Moisture tests must be conducted on all concrete slabs and is especially critical where low VOC or water based adhesives are specified.
 - .3 Carefully monitor test conditions to ensure that tampering or disturbance of the test packs does not affect the results.
 - .4 Maintain a minimum temperature of 13°C for substrates during testing operations.

- .2 Examine substrates, areas, and conditions affecting work are in accordance with manufacturer's requirements, and as follows:
 - .1 Verify that floor surfaces are smooth and flat to plus or minus 3 mm over 3000 mm; notify Consultant in writing where floor tolerances are not within acceptable values.
 - .2 Verify that concrete slabs comply with ASTM F710 and the following:
 - .1 Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond.
 - .2 Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by flooring manufacturer.
 - .3 Verify that concrete slabs exhibit normal alkalinity of between 5 and 9 and that they are free of carbonization or dusting deleterious to flooring installation or adhesive bond.
 - .4 Subfloor finishes comply with requirements specified in Section 03 35 00 for slabs receiving resilient flooring.
 - .5 Verify that subfloors are free of cracks, ridges, depressions, scale, and foreign deposits that could interfere with flooring installation.

3.2 Preparation

- .1 Comply with resilient flooring manufacturer's written installation instructions for preparing substrates indicated to receive flooring.
- .2 Fill cracks, holes, and depressions in substrates using trowellable levelling and patching compounds in accordance with manufacturers written instructions and as follows:
 - .1 Levelling and patching shall be restricted to correcting minor deviations or imperfections to bring floor surface finish to within flooring manufacturers tolerances for flatness.
 - .2 Coordinate finished floor tolerances with Section 03 35 00; this section is not responsible for providing levelling materials to achieve specified floor flatness as measured in accordance with Section 03 35 00.
- .3 Broom and vacuum clean substrates immediately before installing flooring.
- .4 After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.

3.3 Installation

- .1 If required: Install vapour emission control floor sealer in accordance with manufacturer's instructions.
- .2 Comply with resilient flooring manufacturer's written installation instructions.
- .3 Unroll flooring and allow stabilizing before cutting and fitting in accordance with manufacturer's installation instructions.
- .4 Layout tile flooring as follows:
 - .1 Lay tile with joints parallel to building lines or as indicated on drawings to produce a symmetrical tile pattern.
 - .2 Install tile flooring so that perimeter tile width is minimum 1/2 full size.
 - .3 Install to pattern and direction indicated on Drawings.
- .5 Layout sheet flooring as follows:
 - .1 Maintain uniformity of resilient flooring direction.
 - .2 Do not bridge building expansion joints with sheet flooring.

- .3 Arrange for a minimum number of seams, where seams are necessary place them in inconspicuous and low traffic areas, and not less than 150 mm away from parallel joints in flooring substrates.
 - .4 Match edges of flooring for colour shading and pattern at seams in accordance with manufacturer's written recommendations.
 - .5 Obtain Consultant's acceptance in writing before installing materials having cross seams; make adjustments to seaming plan as directed by Consultant to minimize or eliminate cross seams.
 - .6 Weld seams with welding rod where optional with manufacturer in accordance with written instructions for treatment of flooring adjacent to seams:
 - .1 Route joints of sheet flooring, leaving recommended joint profile for welding rod and permanently weld seams in accordance with ASTM F1516
 - .7 Install flooring flush with adjoining floor covering surfaces.
 - .8 Roll sheet flooring in both directions in accordance with manufacturer's instructions:
 - .1 Use flat bladed tool adjacent to walls and door casings, and where access by roller is not practicable.
 - .6 Layout resilient base as follows:
 - .1 Fit joints tight and vertical.
 - .2 Joints along one plane shall be at minimum 7000 mm spacing, at inconspicuous locations.
 - .3 Mitre internal corners, groove and shape back side of base to fit around external corners and exposed ends.
 - .4 Install base on solid backing. Adhere tightly to wall and floor surfaces.
 - .5 Scribe and fit to door frames and other obstructions.
 - .6 Install outside corners prior to installation of straight sections.
 - .7 Install straight and level to variation of plus or minus 3 mm over 3000 mm straight edge.
 - .8 Do not stretch base during installation.
 - .9 Shave back of base where necessary to produce snug fit to substrate.
 - .10 Fill voids along top edge of resilient base with manufacturers recommended adhesive filler material where base is installed on masonry walls.
 - .7 Layout resilient accessories as follows:
 - .1 Install edge strips at unprotected and exposed edges where flooring terminates.
 - .8 Scribe, cut, and fit flooring to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.
 - .9 Extend flooring and base materials into toe spaces, door reveals, closets, and similar openings.
 - .10 Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor using chalk or other non-permanent, non-staining marking device.
- 3.4 Cleaning and Protecting
- .1 Perform the following operations immediately after installing flooring:
 - .1 Remove adhesive and other surface blemishes using cleaner recommended by flooring manufacturer
 - .2 Sweep or vacuum floor thoroughly
 - .3 Do not wash flooring until after time period recommended by flooring manufacturer
 - .4 Damp mop floor to remove marks and soil

- .2 Protect flooring against mars, marks, indentations, and other damage arising from construction operations and placement of equipment and fixtures during the remainder of construction period using protection methods recommended in writing by flooring manufacturer, and as follows:
 - .1 Apply protective floor finish or sealer, as appropriate to the specified materials; coordinate selection of floor polish or sealer with Owner's long term maintenance service.
 - .2 Use only commercially available product acceptable to flooring manufacturer, and provide list of products used as a part of maintenance instructions specified for this Section.
 - .3 Confirm with manufacturer that Owners preferred floor polish or sealer is compatible with manufacturers recommended commercial flooring installation maintenance procedures; notify Consultant where Owner's preferred products are not compatible with manufacturers recommendations.
- .3 Cover flooring with un-dyed, untreated building paper until inspection for Substantial Performance.
- .4 Do not move heavy and sharp objects directly over flooring. Place plywood or hardboard panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.
- .5 Provide final cleaning not more than 4 days before dates scheduled for inspections intended to establish date of Substantial Performance, and as follows:
 - .1 Clean flooring in accordance with manufacturers written recommendations.
 - .2 Clean and strip protective floor finish applied after completing installation only if required to restore polish finish and if recommended by flooring manufacturer.
 - .3 Reapply polish to floor surfaces to restore protective floor finish in accordance with flooring manufacturer's written recommendations.
 - .4 Coordinate with Owner's maintenance program and provide listing of materials required to maintain resilient flooring.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide Vinyl Wall Coverings in accordance with the requirements of the Contract Documents.

1.2 References

- .1 Underwriters Laboratories Canada (ULC):
- .1 CAN/ULC 102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 Administrative Requirements

- .1 Pre-Installation Conference: Conduct conference at Project site, to verify project requirements, substrate conditions, and coordination with adjacent materials, manufacturer's installation instructions and manufacturer's warranty requirements.
- .2 Coordination: Coordinate with Section 09 21 16 for required level of finish of substrate materials; substrate must have a Level 4 Finish in accordance with requirements of Section 09 21 16.

1.4 Submittals

- .1 Product Data: Submit product data for each product specified, indicate physical characteristics, durability, fade resistance and flame resistance characteristics, and required surface preparation materials.
- .2 Samples for Initial Selection: Submit manufacturer's colour charts and samples for initial selection consisting of full range of colours and patterns available for each type of product indicated.
- .3 Samples for Verification: Submit full width x 900 mm long samples from same dye lot as proposed for use on the Project of each colour and texture of wall covering material specified; label the back of each sample indicating quality, colour, texture, weight, manufacturer and supplier and fire resistance rating information.

1.5 Closeout Submissions

- .1 Operation and Maintenance Data: Submit maintenance data for wall covering materials, consisting of precautions for types of cleaning materials and limitations to prevent damage to wall covering materials.
- .2 Spare Parts: Submit 2% of total installed materials in complete rolls and from the same dye lot as installed wall coverings; clearly identify name of material and location within building on outside covering of each roll of material.

1.6 Quality Assurance

- .1 Regulatory Requirements: Provide wall coverings and adhesives with flame spread requirements meeting requirements of the Authority Having Jurisdiction, and tested and labelled in accordance with CAN/ULC 102 or another testing and labelling agency acceptable to Authority Having Jurisdiction.
- .2 Qualifications: Provide proof of qualifications when requested by Consultant:
- .1 Installer: Use installers having a minimum of two (2) years experience in successful application of wall covering for projects of similar scope and complexity.

1.7 Site Conditions

- .1 Ambient Conditions: Maintain air temperature and humidity, and structural base temperature at wall covering installation area within manufacturer's recommended installation tolerances before, during and after installation.
- .2 Lighting: Provide adequate lighting on wall surfaces receiving wall coverings in accordance with manufacturer's installation requirements.
- .3 Ventilation: Ventilate enclosed spaces and provide continuous ventilation during and after coating and adhesive application to maintain air quality; arrange for ventilation system to be operated on maximum outdoor air and exhaust during installation of wall covering materials.

2. PRODUCTS

2.1 Materials

- .1 Vinyl Wall Covering: Indicated as GVF-1, GVF-2, GVF-3, GVF-4 on Section 09 06 06.
- .2 Wall Covering: indicated as WC-1 in Section 09 06 06.

2.2 Accessories

- .1 Substrate Primer/Sealer: White pigmented acrylic base primer/sealer specifically formulated for use with vinyl wall coverings.
- .2 Adhesives: Manufacturer's recommended heavy duty clear premixed vinyl adhesive or clay based adhesive to suit application.

3. EXECUTION

3.1 Examination

- .1 Examine substrates and conditions and confirm that tolerances for smoothness, flatness, levelness, plumb, moisture content and other conditions affecting installation are in accordance with wall covering manufacturer's requirements:
 - .1 Check painted surfaces for pigment bleeding
 - .2 Starting work of this Section will indicated acceptance of conditions

3.2 Preparation of Surfaces

- .1 Prepare surfaces in accordance with manufacturer's written requirements; clean substrates of substances that could impair wall covering bond, including mould, mildew, oil, grease, incompatible primers, dirt, and dust and as follows:
 - .1 Sand gloss, semi-gloss, and eggshell finishes with fine sandpaper
 - .2 Neutralize areas of high alkalinity
 - .3 Treat areas susceptible to pigment bleeding
 - .4 Remove hardware and other wall mounted accessories, electrical plates and covers, light fixtures and trims; store in a safe and secure location, label items with room number and location
- .2 Acclimatized wall covering materials by removing from packaging and storing in the area of installation for time period recommended by manufacturer and to suit site conditions.
- .3 Prime, seal or size wall surfaces as recommended by wall covering manufacturer and in accordance with coating manufacturer's written instructions.

3.3 Installation

- .1 Install wall coverings in accordance with manufacturer's written instructions with no gaps or overlaps, no lifted or curled edges and no visible shrinkage; remove air bubbles, wrinkles, blisters and other defects.
- .2 Installation sequence:
 - .1 Use rolls in consecutive numerical sequence of manufacture
 - .2 Place strips consecutively in exact order they are cut from roll; including spaces above or below windows, doors or similar penetrations
 - .3 Reverse alternate strips except on match patterns
 - .4 Start pattern match at 1830 mm above finish floor surface
- .3 Trim additional selvage where required to achieve colours and pattern match at seams.
- .4 Apply adhesive using a roller or paste brush.
- .5 Hang non-matched patterns by overlapping edges and double cutting through both thicknesses with 1 mm or 1.5 mm thick zinc or aluminum strip back-up to prevent cutting substrate.
- .6 Wrap fabric 150 mm beyond inside and outside corners; no cutting at corners permitted, unless pattern or colour changes.
- .7 No horizontal seams permitted.
- .8 Install wall covering before installation of plumbing fixtures, electrical equipment, casings, bases, cabinets.
- .9 Use stiff bristled brush or flexible broad knife to eliminate air pockets and secure fabric to substrate.
- .10 Remove excess adhesive with damp sponge from seams as work progresses, and wipe clean and dry with cloth towel.
- .11 Leave completed work smooth, clean, without wrinkles, gaps, overlaps or air pockets.

3.4 Closeout Activities

- .1 Clean wall coverings of all adhesives, dust, dirt and other contaminants; replace wall coverings that cannot be cleaned.
- .2 Reinstall hardware and other wall mounted accessories, electrical plates and covers, light fixtures and trims that were removed to facilitate installation of wall coverings.
- .3 Remove debris and leave areas neat and clean.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide acoustic wall panels in accordance with requirements of the Contract Documents.

1.2 Reference Standards

- .1 American Society for Testing and Materials (ASTM):
- .1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 - .2 ASTM D6207, Standard Test Method for Dimensional Stability of Fabrics to Changes in Humidity and Temperature
 - .3 ASTM E795, Standard Practices for Mounting Test Specimens During Sound Absorption Tests
 - .4 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials
- .2 Underwriters Laboratories Canada (ULC):
- .1 CAN/ULC S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

1.3 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish manufacturer's literature, specifications and installation instructions describing the general properties of each material and accessory to be used in the Work.
- .2 Shop Drawings: Submit for Consultant's action. Furnish shop drawings for the fabrication and installation of the Work. Show typical details of the conditions for each type, joint, anchorage and support in the system.
- .3 Samples: Submit for Consultant's action. Label samples to indicate product, characteristics, and locations in the Work. Samples will be reviewed for colour and appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Furnish samples of each type and colour in not less than 200 mm x 280 mm size.

1.4 Quality Assurance

- .1 Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- .2 Field Samples: Prior to the Pre-construction Conference, provide a field sample for each type acoustical ceiling in the building at areas to be designated by the Consultant. Utilize the same materials and installation methods in the sample as required for the final Work. Schedule the installation so that the sample may be examined, and any necessary adjustments made, at least 1 week prior to date scheduled for commencing installation of the Work. When accepted, sample areas shall serve as the standard for materials, workmanship, and appearance for such Work throughout the project and shall remain a part of the final Work.
- .3 Regulatory Requirements: Provide acoustic panel ceilings that meet requirements of ASTM E84 and ULC S102; labelled and listed by Underwriters Laboratories Inc. (UL), Underwriters Laboratories of Canada (ULC) or Warnock Hersey-Intertek (WHI), or another testing and inspecting agency acceptable to Authorities Having Jurisdiction.

1.5 Project Closeout Submissions

- .1 Operation and Maintenance Data: Submit copies of manufacturer's written maintenance information for inclusion in the operations manual; provide specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.
- .2 Spare Parts: Extra Acoustical Materials: Furnish extra stock of each type acoustical panel in a quantity equal to 1% of the amount installed in the Work. Deliver to the Owner and store at the project site where directed.

1.6 Delivery, Storage, And Handling

- .1 Delivery and Acceptance Requirements: Deliver system components to Project site in original, unopened packages and store in a fully enclosed space, protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- .2 Storage and Handling Requirements: Permit system components to reach room temperature and stabilized moisture content before installing; handle system components to avoid damaging units; replace damaged units as directed by Consultant.

1.7 Site Conditions

- .1 Ambient Conditions: Install system components only when building is enclosed, has sufficient heat, when overhead mechanical and electrical work is complete, and dust and moisture producing activities are complete; maintain uniform temperatures and relative humidity within range recommended by material manufacturer from the time of installation until Substantial Performance for the project; make adjustments to temperature and humidity gradually within tolerances indicated by manufacturer.

2. PRODUCTS

2.1 Acoustic Panel

- .1 AWP-1 as indicated in Section 09 06 06.
 - .1 9 mm thick 100% PET, meeting ASTM E84 Class A rating.
 - .2 NRC: 0.65
 - .3 5 mm bevel depth

2.2 Accessories

- .1 Fasteners: as recommended by manufacturer for installation. Construction adhesive for mounting.
- .2 Attachment: Slide and engage clips, magnetic mount, or hook and loop mount, as detailed on Drawings and as recommended by manufacturer for installation type.

3. EXECUTION

3.1 Verification Of Conditions

- .1 Do not begin installation until:
 - .1 Dust generating activities are completed.
 - .2 Other overhead work has been completed.

- .2 Verify the following:
 - .1 Substrate for hanger anchorage is structurally adequate.
 - .2 Existing conditions conform with drawings.
 - .3 Baffles will not interfere with air supply, lighting, sprinkler and sound reinforcement system operation.
- .3 Report nonconforming conditions to Consultant before beginning installation.

3.2 Installation

- .1 Install in accordance with manufacturers written instructions for attachment types.
- .2 Installation in accordance with requirements of the Authority Having Jurisdiction, manufacturers' instructions, and as shown on approved shop drawings. Provide for shimming and adjustments as required to maintain consistent alignment of joints and of finished panel faces, and to ensure unstressed clip locations.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide painting in accordance with requirements of Contract Documents.

1.2 References

- .1 The Master Painters Institute (MPI):
.1 Architectural Painting Specification Manual.

1.3 Definitions

- .1 Gloss Levels: Standard coating terms defined by MPI Manual apply to products of this Section as follows to designate required gloss levels for indicated areas:
- .1 G1 – Matte or Flat: Lustreless or matte finish with a gloss range below 10 when measured at 85° to meter and 0 to 5 when measured at 60°.
 - .2 G2 – Velvet: Matte to low sheen finish with a gloss range of 10 to 35 when measured at 85° to meter and 0 to 10 when measured at 60°.
 - .3 G3 – Eggshell: Low sheen finish with a gloss range of 10 to 35 when measured at 85° to meter and 10 to 25 when measured at 60°.
 - .4 G4 – Satin: Low to medium sheen with a gloss range of minimum 35 when measured at 85° to meter and 20 to 35 when measured at 60°.
 - .5 G5 – Semi-Gloss: Medium sheen finish with a gloss range of 35 to 70 when measured at 60° to meter.
 - .6 G6 – Gloss: High sheen finish with a gloss range of 70 to 85 when measured at 60° to meter.
 - .7 G7 – High Gloss: Reflective sheen having a gloss range in excess of 85 when measured at 60° to meter.

1.4 Submittals

- .1 Submit consent of surety with Bid Submission as proof of ability to supply a 100% two (2) year Maintenance Bond, where local MPI Accredited Quality Assurance Association's guaranty option is not used.
- .2 Drawdown Samples:
- .1 Prior to ordering paint materials, provide to consultant the following for verification purposes: three drawdown sample charts (cards) for each type, texture and colour of finish specified.
 - .1 Apply paint sample in layers to Opacity Charts, by The Leneta Company, or similar, until the paint colour appearance over the black and white areas is identical, or the specified level of opacity has been achieved.
 - .2 Apply paint to Opacity Charts (cards) in an even coat as soon as possible after mixing. Apply enough layers to make the painted area completely opaque, or to the required level of opacity for translucent products.
 - .2 Order paint only for approved Drawdown cards.
 - .3 Final colour selection is by Consultant.
 - .4 Resubmit until approved by Consultant.
 - .5 Consultant will furnish colour chips if alternate colours are to be selected for rejected cards.

- .3 Submit for Consultants action two sets of Material Safety Data Sheets (MSDS) prior to commencement of work for review and for posting at job site as required.
- .4 Submit for Consultants action an itemized list complete with manufacturer, paint type and colour coding for all colours used for Owner's later use in maintenance.

1.5 Quality Assurance

- .1 Conform to the standards contained in the MPI Manual.
- .2 Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in service performance, and as follows:
 - .1 Have a minimum of five (5) years proven satisfactory experience and shall show proof before commencement of work that he will maintain a qualified crew of painters throughout the duration of the work.
 - .2 When requested provide a list of the last three comparable jobs including, name and location, specifying authority, start and completion dates and cost amount of the painting work.
 - .3 Only qualified journeymen who have a Tradesman Qualification Certificate of Proficiency shall be engaged in painting and decorating work.
 - .4 Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.
- .3 Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats and as follows:
 - .1 Use only paint manufacturers and products as listed under the Approved Products section of the MPI Manual Architectural Painting Specification Manual.
 - .2 Use only paint from manufacturers that offer a minimum of five (5) base tints (White/Pastel; Medium; Dark; and a minimum of two additional coloured bases) requiring no more than 90 grams/L of colourant to achieve the scheduled colours, and as follows:
 - .1 Clear or neutral tint base paints will not be acceptable for use on this project.
 - .2 Paints that readily scuff, varnish or oxidize on contact after manufacturer's recommended curing period will not be acceptable for use on this project.

1.6 Environmental Requirements

- .1 Conform to MPI Manual and manufacturer's requirements.
- .2 Perform no painting or decorating work when the ambient air and substrate temperatures, relative humidity and dew point and substrate moisture content is below or above requirements for both interior and exterior work.
- .3 Apply paint only to dry, clean, properly cured and adequately prepared surfaces in areas where dust is no longer generated by construction activities such that airborne particles will not affect the quality of finished surfaces.
- .4 Ensure adequate continuous ventilation and sufficient heating and lighting is in place.
- .5 Paint, stain and wood preservative finishes and related materials (thinners, solvents, caulking, empty paint cans, cleaning rags, etc.) shall be regarded as hazardous products. Recycle and dispose of same subject to regulations of applicable authorities having jurisdiction.
- .6 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into the ground retain cleaning water and filter out and properly dispose of sediments.

- .7 Set aside and protect surplus and uncontaminated finish materials not required by the Owner and deliver or arrange collection for verifiable re-use or re-manufacturing.

1.7 Maintenance Materials

- .1 Leave on the premises not less than 4 liters each of all colours selected.
- .2 Ensure all containers are tightly sealed and clearly labeled.
- .3 Store as directed by the Consultant.

2. PRODUCTS

2.1 Materials

- .1 Paint Materials:
 - .1 To the requirements of the MPI Architectural Painting Specification Manual and conforming to applicable CGSB standards.
 - .2 All Paints: ready mix, pigments fully ground to maintain a soft paste consistency capable of ready and uniform dispersal to a complete and homogeneous mixture.
 - .3 Paints shall have good flowing and brushing properties and be capable of drying or curing free of streaks or sags.
 - .4 All materials and paints shall be lead and mercury free and shall have low VOC content.
- .2 Patching Compound: spackling compound or oil base putty for surfaces receiving an opaque finish. Oil base putty, tinted to match substrate for surfaces receiving a transparent finish.

2.2 Colour Schedule

- .1 Refer to Section 09 06 06 06 for paint colours and gloss levels, indicated as P-1 to P-11.

3. EXECUTION

3.1 Preparation of Surfaces:

- .1 Prepare surfaces in accordance with MPI Manual requirements. Refer to the Manual for specific surface preparation requirements for each substrate material.

3.2 Application

- .1 Apply paint according to manufacturer's written instructions, use applicators and techniques best suited for substrate and type of material being applied, and in accordance with MPI Manual Premium Grade finish requirements, except where additional requirements have been specified.
- .2 Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
- .3 Provide finish coats that are compatible with primers used.
- .4 The term exposed surfaces includes areas visible when permanent or built-in fixtures, grilles, convactor covers, covers for finned-tube radiation, and similar components are in place; extend coatings in these areas as required, to maintain system integrity and provide desired protection, and as follows:
 - .1 Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces.

- .2 Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
 - .3 Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.
 - .4 Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 - .5 Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 - .6 Sand lightly between each succeeding enamel or varnish coat.
- .5 Apply first coat to surfaces that have been cleaned, pre-treated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration, and as follows:
- .1 Apply paint and coatings within an appropriate time frame after cleaning where environmental conditions encourage flash rusting, rusting, contamination or the manufacturer's paint specifications require earlier applications.
 - .2 The number of coats and film thickness required are the same regardless of application method, except that dark tinted colours will require a minimum of four (4) coats with an additional clear urethane or water based light industrial coating type of coating applied in high traffic areas.
 - .3 Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.
 - .4 If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - .5 Omit primer over metal surfaces that have been shop primed and touch-up painted.
 - .6 Apply additional coats until paint film is of uniform finish, colour, and appearance if undercoats, stains, or other conditions show through final coat of paint, giving special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 - .7 Allow sufficient time between successive coats to permit proper drying.
 - .8 Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- .6 Apply paints and coatings by brush, roller, spray, or other application methods according to manufacturer's written instructions and as follows:
- .1 Application methods:
 - .1 Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 - .2 Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 - .3 Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required and as follows:
 - Generally, all paint shall be applied by brush or roller, unless Consultant has given written acceptance for use of spray equipment and methods.
 - The Consultant may at any time prohibit the use of spray painting for such reasons as carelessness, poor masking or protective measures, drifting paint fog, disturbance to other trades or failure to obtain a dense, even, opaque finish.
 - Back roll sprayed surface progressively.
 - .2 Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness recommended by the manufacturer.
 - .3 Sand and dust between each coat to provide an anchor for next coat and to remove defects visible from a distance up to 1220 mm.
- .7 Block Filler:
- .1 Apply block filler at a rate sufficient to fill all voids.

- .2 Tint as required to match succeeding colour coats.
- .3 Apply one full coat of block filler to interior face of all exterior concrete block walls regardless of subsequent finish, including block behind gypsum board but not above ceilings.
- .4 Work block filler well into the surface of the wall, leaving no pinholes or unsealed void in the surface.

3.3 Mechanical and Electrical Paint Application

- .1 Remove grilles, covers and access panels and paint separately. Reinstall after paint is dry.
- .2 Finish paint primed equipment.
- .3 Prime and paint insulated and bare pipes, ducts, conduit, boxes, hangers, brackets, collars and other supports, except where items are plated with a prefinished cladding.
- .4 Replace identification markings on mechanical and electrical equipment when painted over or splattered.
- .5 Paint interior surfaces of air ducts, convectors and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint, to limit of sight line. Paint dampers exposed behind louvers, grilles, convectors and baseboard cabinets to match face panels.
- .6 Paint exposed conduit in finished areas to match adjacent surfaces.
- .7 Paint both faces and all edges of wood backboards for electrical equipment before installing backboards and mounting equipment.
- .8 Paint exposed surfaces of mechanical diffusers white colour.

3.4 Finishing

- .1 Generally and unless otherwise specifically listed in Section 09 99 99, the following paint gloss levels shall prevail:
 - .1 Paint ceilings surfaces using a flat finish.
 - .2 Paint walls using an eggshell finish
 - .3 Paint doors, frames and trim using a semi-gloss finish.
 - .4 Paint walls and ceilings to Premium rating in accordance with MPI Manual Specifications Manual.
 - .5 Paint walls and ceilings in facility laundries, public washrooms, shower and bathrooms, residential kitchens and bathrooms and ensuites using a minimum of one two (2) coats of washable alkyd over appropriate prime/sealer coat.
 - .6 Paint walls and ceilings in public change rooms, washrooms, shower rooms, and institutional facility bathing and shower rooms using a tile-like finish for wettable surfaces.
 - .7 Paint walls and ceilings in public and institutional facility food preparation and sanitary areas using a tile like finish for dry and wettable surfaces.
- .2 Refer to Drawings for location of colours:
 - .1 Colours will be selected by the Consultant from manufacturer's full range of colours.
 - .2 Match other manufacturers products where a specific manufacturer and colour are listed, using materials having similar base tint range listed in above.
 - .3 Gloss level of painted surfaces shall be as specified or as noted on Drawings.
 - .4 Contact Consultant for clarification before ordering and applying materials where no gloss level is specified or indicated.

3.5 Exterior Surfaces

- .1 Paint exterior surfaces in accordance with the MPI Manual painting systems listed in this section.
- .2 Asphalt Surfaces
 - .1 EXT 2.1B – Alkyd Zone / Traffic Marking
- .3 Concrete Vertical Surfaces (including horizontal soffits):
 - .1 EXT 3.1C – Water based light industrial coating G5 finish (over w.b. alkali resistant primer).
- .4 Concrete Horizontal Surfaces
 - .1 EXT 3.2F – Alkyd Zone/Traffic Marking
- .5 Structural Steel and Metal Fabrications:
 - .1 EXT 5.1B – W.B Light Industrial Coating (over inorganic zinc) (current)
- .6 Steel - High Heat (heat exchangers, breeching, pipes, flues, stacks, etcetera, temperature range as noted):
 - .1 EXT 5.2A – Heat resistant enamel - maximum 205°C (400°F).
 - .2 EXT 5.2B – Heat resistant enamel, aluminum – maximum 427°C (800°F).
 - .3 EXT 5.2C – Inorganic zinc coating - maximum 400°C (750°F).
 - .4 EXT 5.2D – High heat resistant coating - maximum 593°C (1100°F).
- .7 Galvanized Metal (not chromate passivated) (doors, frames, railings, misc. steel, pipes, overhead decking, ducts, gutters, flashing, etcetera):
 - .1 EXT 5.3D - Polyurethane, pigmented (over vinyl wash and epoxy primer) (high contact/traffic)
- .8 Cedar siding: stain with sealer

3.6 Interior Surfaces

- .1 Paint interior surfaces in accordance with the MPI Manual painting systems listed in this section.
- .2 Concrete Masonry Units (smooth and split face block and brick):
 - .1 INT 4.2D – High Performance Architectural Latex coating (over latex block filler).
- .3 Structural Steel and Metal Fabrications:
 - .1 INT 5.1B – Water based light industrial coating.
- .4 Steel - High Heat (boilers, furnaces, heat exchangers, breeching, pipes, flues, stacks, etcetera; temperature range as noted):
 - .1 INT 5.2A – Heat resistant enamel finish, maximum 205°C (400°F).
 - .2 INT 5.2B – Heat resistant aluminum paint finish, maximum 427°C (800°F).
 - .3 INT 5.2C – Heat resistant inorganic zinc finish, maximum 400°C (750°F).
 - .4 INT 5.2D – High heat resistant aluminum paint finish, maximum 593°C (1100°F).

- .5 Galvanized Metal (doors, frames, railings, misc. steel, pipes, overhead decking, ducts, etcetera):
 - .1 INT 5.3A – Latex (over cementitious primer)
 - .2 INT 5.3M – High Performance Architectural Latex Finish (over w.b. galvanized primer). High contact areas.
- .6 Plaster and Gypsum Board (gypsum board, drywall, and other sheet gypsum materials):
 - .1 INT 9.2B – High performance architectural latex finish,.
 - .2 INT 9.2F – Epoxy-Modified Latex (Over Latex Primer / Sealer)
 - .3 Scuff resistant paint for corridors and other high traffic areas
- .7 Canvas and Cotton Coverings:
 - .1 INT 10.1A – Latex (over latex primer sealer)
- 3.7 Maintenance Repainting
 - .1 Paint existing exterior and interior previously finished surfaces in accordance with the MPI Manual painting systems listed in this section.
- 3.8 Mechanical and Electrical Equipment
 - .1 Paint “unfinished” conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and texture to match adjacent surfaces, in the following areas:
 - .1 In exposed-to-view exterior and interior areas.
 - .2 In interior high humidity interior areas.
 - .3 In boiler room, mechanical and electrical rooms.
 - .2 Leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks in unfinished areas.
 - .3 Paint inside of ductwork where visible behind louvers, grilles and diffusers beyond sight line with primer and one coat of matt black (non-reflecting) paint.
 - .4 Paint the inside of light valances gloss white.
 - .5 Refer to Mechanical and Electrical specifications for painting, banding, stencilling of other surfaces/equipment, and generally as follows:
 - .1 Paint gas piping gas standard yellow where visible in service spaces.
 - .2 Paint both sides and all edges of plywood backboards for equipment before installation.
 - .3 Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.
 - .4 Do not paint over nameplates.
- 3.9 Field Quality Control
 - .1 Painted surfaces will be considered to lack uniformity and soundness if any of the following defects are apparent at time of field review when viewed from a distance of 1220 mm (48”) from the painted surface:
 - .1 Runs, sags, hiding or shadowing by inefficient application methods.
 - .2 Evidence of poor coverage at rivet heads, plate edges, lap joints, crevices, pockets, corners and re-entrant angles.
 - .2 Painted surfaces will be considered as deficient if any of the following defects are apparent at time of field review, regardless of viewing distance.

- .1 Damage due to touching before paint is sufficiently dry or any other contributory cause.
 - .2 Damage due to application on moist surfaces or caused by inadequate protection from the weather.
 - .3 Damage or contamination of paint due to wind blown contaminants (dust, sand blast materials, salt spray, etcetera).
- .3 Painted surfaces found as unacceptable shall be replaced or repaired at no cost to the Owner or Consultant.
- .1 Small affected areas may be touched up
 - .2 Large affected areas or areas without sufficient dry film thickness of paint shall be repainted.
 - .3 Runs, sags or damaged paint shall be removed by scraper or by sanding before application of new paint coats.
- 3.10 Protection
- .1 Protect newly painted exterior surfaces from rain and snow, condensation, contamination, dust, salt spray and freezing temperatures until paint coatings are completely dry.
 - .2 Curing periods shall exceed the manufacturer's recommended minimum time requirements.
 - .3 Erect barriers or screens and post signs to warn of or limit or direct traffic away or around work area as required.
- 3.11 Restoration
- .1 Clean and re-install all hardware items that were removed before painting operations were undertaken, ensuring that tagged or labelled items are returned to the exact position from which they were removed.
 - .2 Clean, prime and re-paint all bolts, nuts and fasteners after torquing or re-tightening following specified paint finish.
 - .3 Remove protective coverings and warning signs as soon as possible after operations cease.
 - .4 Protect freshly painted surfaces from paint droppings and dust to approval of Consultant. Avoid scuffing newly applied paint.
 - .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Consultant.
- 3.12 Clean-up
- .1 Remove all paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
 - .2 Keep work area free from an unnecessary accumulation of tools, equipment, surplus materials and debris.
 - .3 Remove combustible rubbish materials and empty paint cans each day and safely dispose of it in accordance with requirements of authorities having jurisdiction.

- .4 Clean equipment and dispose of wash water or solvents, and other cleaning and protective materials (rags, drop cloths, masking papers, etcetera), paints, thinners, paint removers and strippers in accordance with the safety requirements of authorities having jurisdiction.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide whiteboards, tack boards, hardware, trim and accessories in accordance with requirements of Contract Documents

1.2 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.

- .1 Product Data: Submit product data for each type of visual display board indicated.
.2 Samples for Initial Selection: Provide Manufacturer's colour charts showing the full range of colours and textures for initial selection of materials for the following:

- .1 Tackboards: sample confirming colour match.

- .2 Shop Drawings: Submit for Consultant's action. Submit shop drawings for each type of visual display board required including, but not limited to, the following:

- .1 Include dimensioned elevations.
.2 Show location of joints between individual panels where unit dimensions exceed maximum panel length.
.3 Include sections of typical trim members.
.4 Show anchors, grounds, reinforcement, accessories, layout, and installation details.

- .3 Samples: Submit for Consultant's action. Submit samples prior to starting work of this section as follows; accepted samples will form the standard of acceptance for the remainder of the work:

- .1 Samples for Verification: Provide samples for verification for the following products, showing colour and texture or finish selected; include sample sets showing the full range of variations expected where finishes involve normal colour and texture variations; prepare Samples from the same material to be used for the Work:
.2 Visual Display Boards: Sample panels not less than 200 mm x 300 mm, mounted on the substrate indicated for the final Work. Include a panel for each type, colour and texture required.
.1 Aluminum Trim and Accessories: Samples of each finish type and colour, on 150 mm long sections of extrusions and not less than 100 mm squares of sheet or plate. Include Sample sets showing the full range of colour variations expected.

1.3 Project Closeout Submissions

- .1 Provide operations and maintenance information.
.2 Submit data for cleaning of finishes and maintenance, and of operational hardware.

1.4 Quality Assurance

- .1 Qualifications: Provide proof of qualifications when requested by the Consultant:
.1 Source Limitations: Obtain pre-manufactured visual display boards through one source from a single manufacturer.
.2 Engage an experienced installer who is an authorized representative of visual display board manufacturer for both installation and maintenance of the type of products required for this Project.

1.5 Site Conditions

- .1 Verify field measurements before preparation of shop drawings and before fabrication to ensure proper fitting and as follows:
 - .1 Coordinate fabrication schedule with construction progress to avoid delaying the Work:
 - .2 Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.
- .2 Establish dimensions and proceed with fabricating visual display surfaces without field measurements where field measurements cannot be made without delaying the work, coordinate wall construction to ensure actual dimensions correspond to established dimensions.

2. PRODUCTS

2.1 Tackboards

- .1 Tack boards: Bulleting Board Tackable Sheet Material: homogenous tackable surface material made of primary natural materials consisting of linseed oil, cork, rosin binders and dry pigments mixed and calendared onto a natural jute backing.
 - .1 Meets or exceeds ASTM F2034
 - .2 Compliant w/ CHPS 01350 VOC emissions
 - .3 Flexibility: Will not crack or break when bent around a 2-3/4" cylinder
 - .4 Thermal Conductivity: +/- 0.1 W/m-K.
 - .5 Noise Reduction: NRC of 0.1 when tested in accordance w/ ASTM C423
 - .6 Resistance to Bacteria: Inhibits growth of organisms such as Staphylococcus Aureas and Clostridium Difficile.
 - .7 Anti-Static
 - .8 Fire Testing: Class 2 (B) when tested in accordance with ASTM E84.
 - .9 Acceptable materials: Forbo Bulletin Board.
- .2 Indicated as TB-1 and TB-2 in Section 09 06 06.

2.2 Marker Boards

- .1 Face Sheet: Minimum 0.62 mm enamelling grade steel specifically processed for temperatures used in coating porcelain on steel to manufacturers standard process, and as follows:
 - .1 Coat exposed face and edges with a 3-coat process consisting of primer, ground coat, and colour cover coat.
 - .2 Coat concealed face with a 2-coat process consisting of primer and ground coat.
- .2 Cover Coats: Provide manufacturer's standard, light coloured, special writing surface with satin finish intended for use with erasable dry markers.
- .3 Core: Use any one of the following core materials to the manufacturer's standard:
 - .1 10 mm thick, particleboard core material complying with requirements of ANSI A208.1, Grade 1 M 1.
 - .2 6 mm thick, tempered hardboard.
 - .3 13 mm gypsum board.
- .4 Backing Sheet: Use any one of the following backing materials to the manufacturer's standard:
 - .1 0.38 mm thick, aluminum sheet backing.
 - .2 0.127 mm thick, aluminum foil sheet backing.
 - .3 0.45 mm thick, galvanized steel sheet backing.

- .5 Laminating Adhesive: Manufacturer's standard, moisture resistant, thermoplastic type adhesive meeting requirements of SCAQMD Rule #1168.
 - .6 Trim and Framing: Extruded aluminum to profiles indicated using manufacturer's standard sections appropriate for installation conditions.
 - .7 Magnetic: magnetic whiteboard panel with metal frame and integrated marker tray:
 - .1 Sizes: as noted on interior elevations on Drawings and selected from manufacturer's standard sizes.
 - .2 Basis-of-Design: Quartet Magnetic Whiteboard with Aluminum Frame.
 - .8 Indicated on Drawings as WB1, WB2, WB3.
- 2.3 Accessories
- .1 Chalk Trough: Manufacturer's standard, plate type, continuous for full length of each installation, complete with end closures and matching trim and frame materials.
 - .2 Maprails: Manufacturer's standard continuous for full length of each installation with cork inserts and end stops and matching trim and frame materials.
 - .3 Joint reinforcement: concealed mechanical jointing system to provide straight, rigid, continuously supported, tight butt, flush joints at surface.
 - .4 Anchor clips, brackets and fasteners: concealed type recommended by manufacturer for fixed mounting.
- 2.4 Fabrication
- .1 Shop fabricated display boards in one piece for lengths 3600 mm or less, for longer sections colour match adjacent pieces.
 - .2 Laminate display board and backing sheet to the core in accordance with the display board manufacturer's recommendations.
 - .3 Apply pre-finished trim in continuous horizontal and vertical lengths, cut and mitred at corners.
- 3. EXECUTION**
- 3.1 Examination
- .1 Inspect Work and conditions affecting the Work of this Section. Proceed only after deficiencies, if any, have been corrected.
 - .2 Ensure that all anchors and setting or installing components provided by this Section for installation are properly located and installed.
- 3.2 Preparation
- .1 Obtain all dimensions from the job site.
 - .2 Provide data, dimensions and components, anchors and assemblies to be installed (where required) in proper time for installation.
- 3.3 Installation
- .1 Erect Work in strict accordance with manufacturer's written instructions.

- .2 Conceal all anchors and fitments. Exposed heads of fasteners not permitted. All joints in exposed work to be flush hairline butt joints.
 - .3 Mount display boards as follows unless otherwise indicated on Drawings:
 - .1 Tack board mounting heights above finished floor level to bottom of board as indicated on Drawings.
 - .4 Refer to drawings for sizes locations, confirmed on site with Owner before installation.
 - .5 Mount on site accessories as indicated.
- 3.4 Cleaning
- .1 At completion and continuously as Work proceeds, remove all surplus materials, debris and scrap.
 - .2 Initial cleaning of whiteboards to be specified to ensure proper erasure as follows:
 - .1 Clean with any liquid ammonia added cleaner and rinse with clear water, then dry.
 - .2 Washing of boards to be done similar to window washing with a sponge and squeegee.
 - .3 At completion of Work, remove all protective surface covering film and wrappings. Clean all frames and hard surfaces using mild soap or other cleaning agent approved by manufacturer.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International
 - .1 [ASTM A123/A123M-09](#), Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 [ASTM A276-10](#), Standard Specification for Stainless Steel Bars and Shapes.
 - .3 [ASTM B209M-10](#), Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate Metric.
 - .4 [ASTM B210M-05](#), Standard Specification for Aluminum-Alloy Drawn Seamless Tubes Metric.
 - .5 [ASTM B211M-03](#), Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire Metric.
- .2 Canadian General Standards Board (CGSB)
 - .1 [CGSB 62-GP-9M-80](#), Prefabricated Markings, Positionable, Exterior, for Aircraft Ground Equipment and Facilities.
 - .2 [CGSB 62-GP-11M-78](#), Marking Material, Retroreflective, Enclosed Lens, Adhesive Backing and Amendment.
- .3 CSA Group (CSA)
 - .1 [CSA G40.20/G40.21-04\(R2009\)](#), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 [CAN/CSA O80 Series-08](#), Wood Preservation.
 - .3 [CSA O121-08](#), Douglas Fir Plywood.
 - .4 [CSA W47.2-11](#), Certification of Companies for Fusion Welding of Aluminum.
 - .5 [CAN/CSA-Z809-08](#), Sustainable Forest Management.
- .4 City of Whitehorse Servicing Standards Manual (2020) - Section 3.21 - Traffic Control and Street Identification Signs.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for traffic signage, including product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Yukon Territory, Canada.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

- .3 Storage and Handling Requirements:
 - .1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Sign supports:
 - .1 Standard tubular supports for small signs: to [ASTM B210M](#)
 - .2 Vertical tubular supports and connecting diagonal members: to [ASTM B210M](#)
 - .3 Truss members: to [ASTM B210M](#)
 - .4 Aluminum tubular members: belt ground satin finish.
 - .5 Anchor and connecting bolts, 'U' clamps and miscellaneous hardware for overhead sign installations: fabricate from 304 stainless steel as specified in [ASTM A276](#)
 - .6 Fasteners: bolts, nuts, washers and other hardware for roadside signs to be cast aluminum alloy, or galvanized steel.
- .2 Signboards:
 - .1 Plywood: to [CSA O121](#), 19 mm thick. Overlaid Douglas Fir, Medium Density [CAN/CSA-Z809](#) or FSC or SFI certified, overlaid one side only with fibre or plastic sheet surfacing material
 - .2 Aluminum sheet: to [ASTM B209M](#), precut to required dimensions
 - .1 Thickness for signboards up to 750 mm wide: 1.6 mm minimum.
 - .2 Thickness for signboards 750-1200 mm wide: 2.1 mm minimum.
 - .3 Thickness for refurbishing existing sign panels: 1.0 mm minimum.
 - .3 Aluminum extrusions: to [ASTM B211M](#), 150 mm or 300 mm panels suitable for bolting together.
 - .4 T-shape stiffeners for signboards: to [ASTM B210M](#)
 - .5 Connecting straps and brackets: to [ASTM B209M](#)
 - .6 Aluminum materials: to [ASTM B209M](#)
 - .7 Reflective sheeting and tape: to [CGSB 62-GP-11M](#). Adhesive, class of reflectivity and colour as indicated.
 - .8 Transparent tape: flexible, smooth-surfaced, moisture resistant tape with pressure sensitive adhesive.

Part 3 Execution

3.1 INSTALLATION

- .1 Sign bridge:

- .1 Erect sign bridge as indicated. Permissible tolerance: 25 mm maximum departure from vertical.
- .2 Sign support:
 - .1 Erect supports as indicated. Permissible tolerance: 50 mm maximum departure from vertical for direct buried supports. Where separate concrete footings have been placed, erect posts with base plates resting on levelling nuts and restrained with nuts and washers. Permissible tolerance: 50 mm maximum departure from vertical.
 - .2 Close open aluminum tubes and posts with aluminum cap. Cut oblong holes in shoe bases to drain condensation. Install aluminum bolt cover on each base plate restraining nut.
 - .3 Erect posts plumb and square to details as indicated.
 - .4 Single channel steel posts:
 - .1 Drive to required depth without damage to posts.
 - .2 If rock or concrete is encountered, drill hole to required depth and set post in sand.
 - .3 In finished concrete surfaces, backfill with concrete or grout. Protect from adverse conditions until cured.
- .3 Signboard:
 - .1 Fasten signboards to supporting posts and brackets as indicated.
 - .2 Fasten lane markers to signboard.
 - .3 Use strapping with crimped or bolted connections where signs fastened to utility poles.

3.2 REPAIR/ RESTORATION

- .1 Prepare new message on 1.0 minimum mm aluminum sheet.
- .2 Install new message on existing signboard in place, or remove existing signboard and install new message before re-erection.
- .3 Rivet new message to existing using 3 mm blind rivets at 300 mm centre to centre maximum around each portion of sheeting and with four, 6 mm diameter stainless steel bolts at corners.

3.3 CORRECTING DEFECTS

- .1 Correct defects, identified by Consultant, in sign message, consistency of reflectivity, colour or illumination. Correct angle of signboard and adjust luminaire aiming angle for optimum performance during night conditions to approval of Consultant.

3.4 CLEANING

- .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by traffic signage installation and salvage operations.

END OF SECTION

1. GENERAL

- .1 **FUTURE installed – Owner will supply and install outside of this Contract. Spec included for information and coordination purposes.**

1.2 Summary

- .1 Provide Electrically Operated Folding Panel Partitions with Vertical Folding Configuration, and suspension system in accordance with the requirements of the Contract Documents.

1.3 Reference Standards

- .1 ASTM International (ASTM):
- .1 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
 - .2 International Organization for Standardization (ISO):
 - .1 ISO 9001, Quality management systems - Requirements

1.4 Submittals

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
- .1 Submit manufacturers' technical data for each type of Folding Panel Partition specified herein.
 - .2 Submit shop drawings showing complete layout of Folding Panel Partition system based on field verified dimensions. The drawings shall include dimensional relationship to adjoining work. Include details indicating materials, finishes, tolerances, and methods of attachment to building steel and electrical requirements.
 - .3 Submit certified test reports evidencing compliance to acoustical STC requirements as specified herein.
- .2 Informational Submittals: Provide the following submittals when requested by the Consultant:
- .1 Certificates: Submit product certificates indicating compliance with specifications each folding panel partition, signed by product manufacturer.
 - .2 Source Quality Control Submissions: Submit certified test reports for folding panel partitions from recognized independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .3 Site Quality Control Submissions: Submit written report prepared by manufacturer verifying compliance with specified performance requirements of installed materials and products.

1.5 Project Closeout Submissions

- .1 Operation and Maintenance Data: Submit manufacturer's written instructions for operation and maintenance procedures, include name of original installer and contact information in accordance with and as follows:
- .1 Panel finish facings and finishes for exposed trim and accessories; include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
 - .2 Seals, hardware, track, carriers, and other operating components.

- .2 Parts: Submit extra materials described below that match installed products.

1.6 Quality Assurance

- .1 All work and materials specified herein, shall be installed only by qualified representatives and/or installers and/or distributors of the manufacturer, according to the manufacturers written instructions.
- .2 The Folding Panel Partition must be manufactured by a certified ISO-9001 company or an equivalent quality control system.

1.7 Delivery, Storage and Handling

- .1 Deliver equipment to site in manufacturer's standard packages. Store and handle as recommended by manufacturer.

1.8 Site Conditions

- .1 The floor underneath the Folding Panel Partition along its axis shall be flat to within +/- 6 mm over the entire length of a Folding Panel Partition. The peak to valley undulation of +/- 6 mm shall not be closer together than 610 mm and a peak to valley undulation of +/- 3 mm shall not be closer than 305 mm.
- .2 Support steel above the Folding Panel Partition along its axis shall be parallel to the floor within +/- 12.7 mm for the entire length of the Folding Panel Partition. This includes loaded deflection. The beam must also be parallel to the center line of the wall within ± 3 mm, left to right.
- .3 The fixed walls at either end of the Folding Panel Partition shall be within +6 mm-0 mm, from plumb vertical.
- .4 The fixed walls at either end of the Folding Panel Partition shall be flat to within + 0 mm, -6 mm.

1.9 Warranty

- .1 Folding Panel Partition: warranted free from defects in material and workmanship for a period of two years or five thousand cycles and the parts only will be free from defect for a period of ten years or five thousand cycles, whichever occurs first from date of shipment.
- .2 Parts and labour required to maintain the Folding Panel Partition and part subject to normal wear and tear are not covered under the warranty and are the Owner's responsibility.

2. **PRODUCTS**

2.1 Materials

- .1 Panels: Automatic vertically retractable acoustic wall, folded upward vertically without the use of manual labor, into a pocket in ceiling.
 - .1 Thickness: as indicated an Drawings
 - .2 Height: as indicated an Drawings
 - .3 Face: Steel laminated to substrate to meet STC Requirement
 - .4 Speed: 1.5 to 3 meters per minute.
 - .5 Sound Seal: Tongue and groove configuration, ensure panel to panel alignment and prevent sound leaks between panels
 - .6 Panel Edges: right angled, minimum radius not more than 1.6 mm.
 - .7 Safety Sensor: Retractable safety sensor seal, minimum 51 mm floor adjustability
 - .8 Weight: 34.2 kg/sq m

- .2 Folding Mechanism
 - .1 Hanging, folding and extension mechanism, made from structural grade aluminum extrusions and structural shapes.
 - .2 Wear surfaces to be designed to function quietly and with minimum wear, over the 10,000 cycle design life of operable wall.
 - .3 Fabricate hangers from steel and welded or bolted to support steel.
 - .3 Motor Drive:
 - .1 Motor Drive: sized properly to open and close wall effectively over 10,000 cycle design life of wall, at the minimum design speed. Mounted directly above centre line of operable wall.
 - .2 Folding Mechanism: Designed to function smoothly, quietly and safely. Ball bearings to be used instead of bushings and wear surfaces.
 - .3 Wire rope cable for every set of folding mechanism. Aircraft cable and made of galvanized steel. Diameter of cables sized to hold entire weight of wall, with appropriate safety factor.
 - .4 Cable wraps on yoyo drums with 2 safety wraps and multiple layers of cable.
 - .5 Line shaft, sized to deliver the required torque with minimum deflection, support and rotate cable drums.
 - .6 Flange bearings used for drive system, located immediately on both sides of drum assembly.
 - .7 Motor drive sized to deliver sufficient amount of torque to safely and effectively raise and lower operable wall over its design life.
 - .4 Electrical
 - .1 Power Supply: Three phase power supply to electrical control box.
 - .2 Standard electrical control box: NEMA 1.
 - .3 Low voltage wiring: Coordinate with Electrical for requirements.
 - .4 Switches: Two (2) push button switches wired in series with power controlled by a single, three position key switch. One push button switch equipped with LED that flashes fault codes in case of an electrical system failure.
 - .5 Safety:
 - .1 Brake: Electromagnetic type of brake which activates firmly, without hesitation, when power is lost to system. Minimum retarding torque rating equal to 200% of motor drive's full load torque. Drive system equipped with manual override and brake release lever.
 - .2 Dynamic brake: Distinct and separate from the brake above, in order to lower wall at controlled speed of no more than approximately 150% of the normal down speed, in the case of catastrophic failure in motor drive's power train.
 - .3 Switches: Employ electrical or other limit switches in order to stop wall at its up and down travel limits.
 - .4 Torque Detector: Mechanical, using motor's torque arm in its over torque detection. Senses jam in system and to act as an over travel limit in up direction should the primary limit switch fail.
 - .6 Acoustical performance
 - .1 Acoustical performance tested in accordance with ASTM E90 and achieve an STC rating of the following:
 - .1 Panel Construction: STC 60
- 2.2 Finishes
- .1 Apply finishes in a horizontal direction.

- .2 Finish: As selected by Consultant and as follows:
 - .1 Maximum weight of material: 0.542 kg/m²
 - .2 Maximum thickness of material: 3 mm
 - .3 No brittle materials.
 - .4 Finishes are railroaded onto panels, applied horizontally along panel length.
- .3 Exposed metal trim and seal colour: Manufacturers standard colour as selected by Consultant.

2.3 Operation

- .1 Partitions are key switch controlled, requiring constant contact to activate the motor.
- .2 Motor drive automatically seal the partition in the opening.
- .3 Stack and Store panels:
 - .1 Retract above ceiling and stored by activating the key switch control.
- .4 Extend partition: When operable wall is being lowered, panels will stop if leading edge comes into contact with an object between the panel and the floor.

3. EXECUTION

3.1 Installation

- .1 Install Folding Panel Partitions in accordance with the manufacturer's printed instructions.
- .2 The Folding Panel Partition supplier shall not deliver or install this product until the Contractor can ensure in writing safe storage and protection for the wall for the duration of the project.

3.2 Adjusting and Cleaning

- .1 Adjust and fine-tune the Folding Panel Partitions to ensure that all seals are operating and sealing properly and that the walls are in correct and smooth operation.
- .2 Clean up any dirt, oil, grime, etc., that may have found its way onto the acoustical panels. Leave the wall in a state of architectural cleanliness.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide wall protection in accordance with requirements of Contract Documents.
- .2 Indicated in Section 09 06 06 as FRP-1, WP-1, WWP-1, WWP-2, CR-1, CG-1, CG-2

1.2 Reference Standards

- .1 ASTM International (ASTM):
 - .1 ASTM A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

1.3 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
 - .1 Submit product data including construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes for each impact resistant wall protection unit.

1.4 Quality Assurance

- .1 Installer Qualifications: Only installers who have completed the manufacturer's authorized training program, and who are approved for both installation and maintenance of specified impact resistant wall protection units will be acceptable for this Project.
- .2 Source Limitations: Obtain impact resistant wall protection units through one source from a single manufacturer.

1.5 Delivery, Storage, and Handling

- .1 Store impact resistant wall protection units in original undamaged packages and containers inside well ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity:
 - .1 Maintain room temperature within storage area at not less than 21°C during the period plastic materials are stored.
 - .2 Keep plastic sheet material out of direct sunlight.
 - .3 Store plastic wall protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 21°C:
 - .1 Store corner guard covers in a vertical position.

1.6 Project Conditions

- .1 Deliver and install impact resistant wall protection units after building is enclosed and weatherproof, when wet work is complete and dry, and HVAC system is operating and maintaining temperature at 21°C for not less than 72 hours before beginning installation and for the remainder of the construction period.
- .2 Verify actual locations of walls, columns, and other construction contiguous with impact resistant wall protection units by field measurements before fabrication and indicate measurements on shop drawings.

1.7 Warranty

- .1 Submit manufacturer's standard warranty agreeing to repair or replace components of impact resistant wall protection units that fail in materials or workmanship within five (5) years from date of Substantial Performance for the Project; Consultant will identify failures as the following:
 - .1 Structural failures.
 - .2 Deterioration of plastic and other materials beyond normal use.

2. **PRODUCTS**

2.1 Materials

- .1 Extruded Rigid Plastic: ASTM D1784, Class 1, textured, chemical and stain resistant, high impact resistant PVC or acrylic modified vinyl plastic with integral colour throughout; and as follows:
 - .1 Impact Resistance: Minimum 1.36 kN of notch in accordance with ASTM D256, Test Method A.
 - .2 Chemical and Stain Resistance: In accordance with ASTM D543.
 - .3 Self extinguishing in accordance with ASTM D635.
 - .4 Flame Spread Index: 25 or less.
 - .5 Smoke Developed Index: 450 or less.
- .2 Plastic Sheet Wall Covering Material: ASTM D1784, Class 1, textured, chemical and stain resistant, semi-rigid, high impact resistant PVC or acrylic modified vinyl plastic sheet with integral colour throughout; and as follows:
 - .1 Impact Resistance: Minimum 1.36 kN of notch in accordance with ASTM D256, Test Method A.
 - .2 Chemical and Stain Resistance: In accordance with ASTM D543.
 - .3 Self extinguishing in accordance with ASTM D635.
 - .4 Flame Spread Index: 25 or less.
 - .5 Smoke Developed Index: 450 or less.
- .3 Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated but with not less than strength and durability properties specified in ASTM B221 for Alloy 6063 T5.
- .4 Stainless Steel Sheet: ASTM A240/A240M.
- .5 Fasteners: Aluminum, nonmagnetic stainless steel, or other non-corrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security type fasteners where exposed to view.
- .6 Adhesive: Type recommended by manufacturer for use with material being adhered to substrate indicated.

2.2 Impact Resistant Wall Coverings

- .1 Semi-rigid, Impact Resistant Sheet Wall Covering: Fabricated from plastic sheet wall covering material, and as follows:
 - .1 Size: 1220 mm x 2440 mm: height
 - .2 Sheet Thickness: 0.09"
 - .3 Mounting: Adhesive.
 - .4 FRP-1 as indicated in Section 09 06 06.

- .2 Semi-rigid, Impact Resistant Sheet Wall Covering: Fabricated from plastic sheet wall covering material, and as follows:
 - .1 Size: 1220 mm x 2440 mm
 - .2 Sheet Thickness: 0.09"
 - .3 Mounting: Adhesive.
 - .4 WP-1 as indicated in Section 09 06 06.

- 2.3 Wall Mounted Wood Planks
 - .1 WWP-1 and WWP-2 in Section 09 06 06:
 - .1 WWP-1:
 - .1 Manufacturer: Armstrong
 - .2 Type: Woodworks Linear Veneered Planks
 - .3 Type Number: Custom pattern
 - .4 Size: 2438mm x 95mm x 95mm with 19mm reveal
 - .5 Colour: Quartered Walnut
 - .2 WWP-2:
 - .1 Manufacturer: Odyssey Wallcovering
 - .2 Type: Acoustic Woodwerx - Online
 - .3 Size: 96" x 12.8" panel
 - .4 Colour: white oak

- 2.4 Corner Guards
 - .1 CG-1 Surface Mounted, Metal Corner Guards: Fabricated from single piece, formed metal with eased edges; bend angle turn to match wall condition, and as follows:
 - .1 Material: Stainless steel, Type 304.
 - .2 Thickness: Minimum 1.519 mm.
 - .3 Finish: Directional satin, No. 4.
 - .4 Wing Size: Nominal 65 mm x 65 mm.
 - .5 Corner Radius: 3 mm.
 - .6 Mounting: Flat head, countersunk screws through factory drilled mounting holes.
 - .2 CG-2: Stainless steel:
 - .1 Style: Pawling CG-50
 - .2 Size: 90mm
 - .3 Radius: Standard
 - .4 Finish: Satin Finish
 - .5 From top of base to 2200mm

- 2.5 Fabrication
 - .1 Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

- 2.6 Metal Finishes
 - .1 Remove tool and die marks and stretch lines or blend into finish.
 - .2 Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
 - .3 Passivate and rinse surfaces when polishing is completed.

- .4 Remove embedded foreign matter and leave surfaces chemically clean.
- .5 Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3. EXECUTION

3.1 Examination

- .1 Examine substrates and wall areas for compliance with manufacturer's requirements for installation tolerances and other conditions affecting performance of work.
- .2 Examine walls that will receive impact resistant wall protection and verify that blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
- .3 Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers for impact resistant wall protection units attached with adhesive.
- .4 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Preparation

- .1 Complete finishing operations, including painting, before installing impact resistant wall protection system components.
- .2 Clean substrate to remove dust, debris, and loose particles before installation.

3.3 Installation

- .1 Install impact resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- .2 Install impact resistant wall protection units in locations and at mounting heights indicated on Drawings.

3.4 Cleaning

- .1 Clean plastic covers and accessories using a standard, ammonia based, household cleaning agent immediately after completion of installation.
- .2 Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide toilet accessories in accordance with requirements of Contract Documents

1.2 Reference Standards

- .1 American Society for Testing and Materials (ASTM):

- .1 ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
.2 ASTM A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
.3 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
.4 ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

- .2 Canadian General Standards Board (CGSB):

- .1 CAN/CGSB-12.5, Mirrors, Silvered

- .3 Canadian Standards Association (CSA):

- .1 CSA B651, Accessible Design for the Built Environment

- .4 International Code Council (ICC)

- .1 ICC A117.1, Standard for Accessible and Usable Buildings and Facilities

1.3 Submittals

- .1 Product Data: Submit for Consultant's action product data including construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.
.2 Samples: Submit for Consultant's action samples for each accessory item to verify design, operation, and finish requirements; accepted full size samples will be returned and maybe used in the Work.
.3 Shop Drawings: Submit for Consultant's action, setting drawings for cut outs required in other work; include templates, substrate preparation instructions, and directions for preparing cut outs and installing anchoring devices.

1.4 Quality Assurance

- .1 Regulatory Requirements: Install toilet accessories in accordance with CSA B651 at accessible washroom locations.
.2 Qualifications: Provide proof of qualifications when requested by Consultant:
.1 Manufacturer: Obtain products from a single manufacturer for each type of accessory unit and for units exposed to view in the same area.

1.5 Delivery, Storage And Handling

- .1 Delivery and Handling Requirements: Deliver washroom accessories in manufacturer's original, undamaged packaging, clearly marked for contents and location within building.

2. PRODUCTS

2.1 Manufacturers

- .1 Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; additional manufacturers offering similar products may be incorporated into the work of this Section provided they meet the performance requirements established by the named products and provided they submit requests for substitution.

2.2 Materials

- .1 Provide one of the products indicated for each designation in the Washroom and Custodial Accessory Schedule below subject to compliance with specified requirements.
- .2 Stainless Steel: In accordance with ASTM A666, Type 304, with No. 4 finish (satin); minimum nominal thickness as established by product type.
- .3 Sheet Steel: Steel: In accordance with ASTM A366/A366M, cold rolled, commercial quality; minimum nominal thickness as established by product type; surface preparation and metal pretreatment as required for applied finish.
- .4 Galvanized Steel Sheet: In accordance with ASTM A653/A653M, minimum Z180 coating designation.
- .5 Mirror Glass: In accordance with CGSB 12.5; Type 1B for high humidity use, 6 mm nominal thickness, with silvering, electroplated copper coating, and protective organic coating. Refer to Section 08 81 00 for frameless mirrors.
- .6 Galvanized Steel Mounting Devices: In accordance with ASTM A153/A153M, hot dip galvanized after fabrication.
- .7 Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.3 Fabrication

- .1 Surface Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless steel hinge. Provide concealed anchorage where possible.
- .2 Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all welded construction, without mitred corners. Hang doors and access panels with full length, stainless steel hinge. Provide anchorage that is fully concealed when unit is closed.
- .3 Framed Glass Mirror Units: Fabricate frames for glass mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper resistant glass installation and prevents moisture accumulation:
- .1 Provide galvanized steel backing sheet, not less than 0.95 mm (0.038" (20 ga.)) and full mirror size, with no-absorptive filler material. Corrugated cardboard is not an acceptable filler material.

- .4 Mirror Unit Hangers: Provide mirror unit mounting system that permits rigid, tamper and theft resistant installation, as follows:
 - .1 Heavy duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
- .5 Keys: Provide universal keys for internal access to accessories for servicing and resupplying.
- .6 Provide minimum of six keys to Owner's representative.
- .7 Labels:
 - .1 Exposed Faces: Provide maximum 38 mm Ø, unobtrusive stamped manufacturer logo
 - .2 Interior or Non-Exposed Faces: Provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.
- .8 Disposable supplies: Provide a list of disposable supplies to the Owner required by fixtures, including but not limited to toilet paper, paper towels, feminine hygiene products, soap and other items required for first fill.

3. EXECUTION

3.1 Examination

- .1 Examine site conditions where Work will be applied and ensure acceptability for complete and satisfactory installation; beginning of installation will denote acceptance of site conditions.

3.2 Preparation

- .1 Verify wall thickness and construction that will accept recessed accessories.
- .2 Verify that solid blocking for support and anchoring of washroom accessories is installed where required.
- .3 Verify that frames and anchors provided, whether by this Section or others, are correctly and securely installed ready to accept the accessory scheduled for the specific location.
- .4 Verify that painting is complete and dry in area of installation before accessories are installed.

3.3 Installation

- .1 Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- .2 Conform to mounting heights indicated on as indicated on Drawings and meeting accessibility requirements listed in CSA B651; confirm locations prior to site installation.
- .3 Secure mirrors to walls in concealed, tamper resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated.
- .4 Install grab bars to withstand a downward load of at least 1.1 kN (250 lbf), when tested according to method in ASTM F446.
- .5 Locate accessories to approximate areas as indicated on Drawings; exact locations will be determined by the Consultant.

3.4 Adjusting And Cleaning

- .1 Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.
- .2 Remove temporary labels and protective coatings.
- .3 Clean and polish exposed surfaces in accordance with manufacturer's written recommendations.

3.5 Toilet And Bath Accessory Schedule

- .1 Refer to Drawings for washroom accessories.

No.	Description/Model
BCT	<p>Baby Change Table: Surface mounted, horizontal design, stainless steel, prefabricated baby changing station with built-in sanitary liner dispenser and safety belt, complete with initial stocking supplies and stocking list for replacement stock:</p> <p style="padding-left: 40px;">Frost 1125 Kidz Zone Change Station Bobrick / Koala Kare KB200-SS Horizontal Change Station Safe Strap Wall Mounted Changing Station</p>
ACT	<p>Adult Change Station: adjustable height, refer to end of this section for electrical requirements:</p> <p style="padding-left: 40px;">Bobrick / Koala Kare KB3000-AHL</p>
CH	<p>Coat Hooks: Satin finished stainless steel, square profiled double robe hook with concealed mounting, [provide 2 for each washroom,] located as directed by Consultant:</p> <p style="padding-left: 40px;">ASI 7345-S Bobrick B-76727 Bradley 9124 Frost 1139S</p>
GB1	<p>Grab Bar: Horizontal 1.214 mm thickness; 600 mm long x 38 mm Ø, straight, stainless steel, slip resistant grip, concealed mounting, cap secured with vandal resistant set screws:</p> <p style="padding-left: 40px;">ASI 3801-24P Bobrick B-6806.99x24 Bradley 812-001-24-2 Frost 1001DPx48</p>
GB2	<p>Grab Bar: Horizontal 1.214 mm thickness; 750 mm long x 38 mm Ø, 90 degree, stainless steel, slip resistant grip, concealed mounting, cap secured with vandal resistant set screws.</p>

No.	Description/Model								
G3	<p>Grab Bar: Horizontal Two (2) – 1.214 mm thickness; 600 mm long x 38 mm Ø, straight, stainless steel, slip resistant grip, concealed mounting, cap secured with vandal resistant set screws. Install vertical:</p> <table data-bbox="597 401 959 537"> <tr> <td>ASI</td> <td>3801-24P</td> </tr> <tr> <td>Bobrick</td> <td>B-6806.99x24</td> </tr> <tr> <td>Bradley</td> <td>812-001-24-2</td> </tr> <tr> <td>Frost</td> <td>1001DPx24</td> </tr> </table>	ASI	3801-24P	Bobrick	B-6806.99x24	Bradley	812-001-24-2	Frost	1001DPx24
ASI	3801-24P								
Bobrick	B-6806.99x24								
Bradley	812-001-24-2								
Frost	1001DPx24								
G5	<p>Grab Bar: Vertical 1.214 mm thickness; 915 mm long x 38 mm Ø, straight, stainless steel, slip resistant grip, concealed mounting, cap secured with vandal resistant set screws:</p> <table data-bbox="597 667 959 804"> <tr> <td>ASI</td> <td>3801-36P</td> </tr> <tr> <td>Bobrick</td> <td>B-6806.99x36</td> </tr> <tr> <td>Bradley</td> <td>812-001-36-2</td> </tr> <tr> <td>Frost</td> <td>1001DPx36</td> </tr> </table>	ASI	3801-36P	Bobrick	B-6806.99x36	Bradley	812-001-36-2	Frost	1001DPx36
ASI	3801-36P								
Bobrick	B-6806.99x36								
Bradley	812-001-36-2								
Frost	1001DPx36								
WR1	<p>Recessed Waste Receptacle: Recessed waste receptacle type-304 stainless steel with all-welded construction; exposed surfaces satin finish. Flange drawn and beveled, one-piece, seamless construction. Removable waste receptacle secured to cabinet with tumbler lock keyed like other washroom accessories, have front and side edges of bottom and all top edges hemmed for safe handling. capacity of 12-gal. (45.4-L).</p> <table data-bbox="597 1031 878 1167"> <tr> <td>ASI</td> <td>0458</td> </tr> <tr> <td>Bobrick</td> <td>B-3644</td> </tr> <tr> <td>Bradley</td> <td>334</td> </tr> <tr> <td>Frost</td> <td>337</td> </tr> </table>	ASI	0458	Bobrick	B-3644	Bradley	334	Frost	337
ASI	0458								
Bobrick	B-3644								
Bradley	334								
Frost	337								
M1	<p>Mirror: Framed 450 x 1000 channel frame mirror. Mounting height as indicated on Typical Mounting Height drawing.</p>								
M2	<p>Mirror: Framed, 450 x 750 channel frame mirror; mounting height as indicated on Typical Mounting height drawing.</p>								
M3	<p>Mirror: Frameless Mirror as specified in Section 08 81 00. 900 high x length of vanity.</p>								
MH-1	<p>Mop Strip: Stainless steel mop and broom holder with non-slip handle restraints, designed to hold four (4) handles and three (3) stainless steel hooks:</p> <table data-bbox="597 1545 911 1682"> <tr> <td>ASI</td> <td>8215-4</td> </tr> <tr> <td>Bobrick</td> <td>B-224x36</td> </tr> <tr> <td>Bradley</td> <td>9953</td> </tr> <tr> <td>Frost</td> <td>1113</td> </tr> </table>	ASI	8215-4	Bobrick	B-224x36	Bradley	9953	Frost	1113
ASI	8215-4								
Bobrick	B-224x36								
Bradley	9953								
Frost	1113								

No.	Description/Model																
SN-1	<p>Feminine Napkin Disposal: Surface mounted, concealed fastening, self closing disposal opening with leak proof plastic receptacle and 10 disposable liners for initial stocking purposes for each unit:</p> <table data-bbox="597 401 894 537"> <tr><td>ASI</td><td>0852</td></tr> <tr><td>Bobrick</td><td>B-270</td></tr> <tr><td>Bradley</td><td>4781-15</td></tr> <tr><td>Frost</td><td>622</td></tr> </table> <p>Shelf: Surface mounted adjacent to each ND, folding utility shelf, 1.214 mm thickness stainless steel, satin finished or chrome plated zinc die cast to meet manufacturers standard, nominal 146 mm wide x 370 mm long:</p> <table data-bbox="597 642 865 779"> <tr><td>ASI</td><td>0698</td></tr> <tr><td>Bobrick</td><td>B-287</td></tr> <tr><td>Bradley</td><td>790</td></tr> <tr><td>Frost</td><td>955</td></tr> </table>	ASI	0852	Bobrick	B-270	Bradley	4781-15	Frost	622	ASI	0698	Bobrick	B-287	Bradley	790	Frost	955
ASI	0852																
Bobrick	B-270																
Bradley	4781-15																
Frost	622																
ASI	0698																
Bobrick	B-287																
Bradley	790																
Frost	955																
PTD1	<p>Paper Towel Dispenser: Surface mounted, capable of holding 200 'C' fold or multi-fold paper towels, stainless steel finish, thumb turn lock:</p> <table data-bbox="597 877 878 1014"> <tr><td>ASI</td><td>0215</td></tr> <tr><td>Bobrick</td><td>B-2621</td></tr> <tr><td>Bradley</td><td>252</td></tr> <tr><td>Frost</td><td>103</td></tr> </table>	ASI	0215	Bobrick	B-2621	Bradley	252	Frost	103								
ASI	0215																
Bobrick	B-2621																
Bradley	252																
Frost	103																
SD1	<p>Soap Dispenser: Counter surface mounted stainless steel liquid soap dispenser. 1L capacity, 152 mm spout length.</p> <table data-bbox="597 1102 902 1239"> <tr><td>ASI</td><td>0332-CD</td></tr> <tr><td>Bobrick</td><td>B-82216</td></tr> <tr><td>Bradley</td><td>6326-68</td></tr> <tr><td>Frost</td><td>N/A</td></tr> </table>	ASI	0332-CD	Bobrick	B-82216	Bradley	6326-68	Frost	N/A								
ASI	0332-CD																
Bobrick	B-82216																
Bradley	6326-68																
Frost	N/A																
TD1	<p>Toilet tissue dispenser with shelf: Surface mounted, 2 roll, stainless steel finish, holds rolls up to 140 mm diameter.</p> <table data-bbox="597 1339 881 1440"> <tr><td>ASI</td><td>0697</td></tr> <tr><td>Bobrick</td><td>B-2840</td></tr> <tr><td>Bradley</td><td>5263</td></tr> </table>	ASI	0697	Bobrick	B-2840	Bradley	5263										
ASI	0697																
Bobrick	B-2840																
Bradley	5263																
SC1	<p>Sharps Container: Cardinal 8516H by McKesson. ABS plastic, wall mount.</p>																

Coordinate metal backing thickness with Section 09 21 16 - Gypsum Board Assemblies

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide metal lockers in accordance with requirements of the Contract Documents
- .2 Indicated as LK-1 and LK-2 in Section 09 06 06.

1.2 Definitions

- .1 Base Metal Thickness: Uncoated steel sheet thicknesses indicated as the minimum nominal thickness in this Section and variations permissible under CGSB 44.40.

1.3 References

- .1 ASTM International (ASTM):
 - .1 ASTM A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 44.40, Steel Clothing Locker

1.4 Coordination

- .1 Coordinate size and location of bases for metal lockers.
- .2 Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related work specified in other Sections so that metal lockers can be supported and installed as indicated.

1.5 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
- .2 Shop Drawings: Submit for Consultant's action: Provide the following submittals before starting work of this section:
 - .1 Type and class of locker.
 - .2 Thicknesses of metal.
 - .3 Fabricating and assembly methods.
- .3 Samples: Submit for Consultant's action:
 - .1 Submit two (2) - 50 mm x 50 mm samples of each colour on actual base metal indicating colour match to specified finish.

1.6 Quality Assurance

- .1 Installer shall be an authorized representative of metal locker manufacturer for installation and maintenance of units required for this Project.
- .2 Obtain metal lockers and accessories through one source from a single manufacturer. Do not modify intended aesthetic appearance of metal lockers without the Consultant's written approval; submit comprehensive explanatory data to Consultant for review where modifications are necessary to meet project requirements before submission of Bids.

1.7 Delivery, Storage, and Handling

- .1 Transport metal lockers to site for standard delivery Contractor's construction schedule when installation spaces are clean, dry, and ready for metal locker installation.

1.8 Project Conditions

- .1 Site Measurements: Verify location of concealed framing, blocking, and reinforcements that support metal lockers before they are enclosed, and configuration of recessed openings by Site measurements before fabrication and indicate measurements on Shop Drawings.
- .2 Established Dimensions: Establish recessed opening dimensions and proceed with fabricating metal lockers without Site measurements where Site measurements cannot be made without delaying the Work. Coordinate wall and floor construction so that actual recessed opening dimensions correspond to established dimensions.

2. PRODUCTS

2.1 Manufacturers

- .1 Acceptable Materials Manufacturers: Subject to compliance with requirements specified in this Section, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 Access SMT (formerly Shanahan's Manufacturing Ltd.)
 - .2 Canadian Locker Company Limited
 - .3 General Storage Systems
 - .4 Hadrian Inc.

2.2 Materials

- .1 Cold Rolled Steel Sheet: Commercial Steel (CS) Type B in thicknesses indicated, suitable for exposed applications in accordance with ASTM A1008/A1008M.
- .2 Fasteners: Zinc or nickel plated steel, slotless type exposed bolt heads, and self-locking nuts or lock washers for nuts on moving parts.
- .3 Anchors: Select material, type, size, and finish required for secure anchorage to each substrate, as follows:
 - .1 Provide nonferrous metal or hot dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.
 - .2 Provide toothed steel expansion sleeves for drilled-in-place anchors.

2.3 Manufactured Units

- .1 Lockers: Fabricate in accordance with CGSB 44.40, and as follows:
 - .1 Type: Type 1 Single tier, size as indicated on Drawings

- .2 Class: Class 2 - A bank of two or more lockers
 - .3 Installation: Freestanding.
 - .4 Size: refer to Drawings.
 - .5 Frame: Minimum 1.519 mm steel channel welded to form one piece construction.
Continuous built-in doorstep.
 - .6 Body Thickness: Minimum 0.70 mm, base metal thickness.
 - .7 Assembly: Welded construction.
 - .8 Top: flat
 - .9 Doors: One piece double wall envelope construction, steel thickness 1.52 mm outer panel,
0.7 mm inner panel, laminated to honeycomb core.
 - .10 Sound-Dampening Panels: Manufacturer's standard door stiffeners designed to reduce
sound levels when doors are closed.
 - .11 Door Handle: stainless steel plated steel pocket for use with padlock, insert flush with
door. Plastic not acceptable.
 - .12 Door Strike: Continuous, with two (2) rubber door mates.
 - .13 Door Flanges: Welded
 - .14 Door Style: Vented panel top and bottom, vandal resistant vents in accordance with
manufactures standards
 - .15 Hinges: 1.52 mm thick steel continuous hinges or 5 knuckle 2.0 mm thick hinges with non-
removable pins, two (2) per door.
 - .16 Locking System: Padlocks supplied by Owner for single point locking as follows:
 - .1 Non-moving latch hook with steel padlock loop that projects through recessed
cup and is finished to match metal locker body.
 - .2 Latch Hook: Equip each door with 1 latch hook, fabricated from minimum
2.657 mm thick steel; welded midway up full-height door strike; with resilient
silencer.
 - .17 Basis-of-Design: Access SMT (formerly Shanahan's) Deluxe ST
- .2 Accessories: Meeting CGSB-44.40 and as follows:
- .1 Coat Hooks: three single wall coat hooks, steel with chromium finish.
 - .2 Shelf: none.
 - .3 Base: Pressure treated plywood for wet areas, standard plywood for remaining locations.
Refer to Section 06 10 00.
 - .4 End Panels: Boxed end panels to match body panel colour.
 - .5 Trim: Steel trim to manufacturer's standard including corner angles, jamb trim and fillers.
 - .6 Number Plates: Sequence numbered to match Owner's Standard. Inset in finger pull,
tamper and vandal proof.
 - .7 Flat Top: Manufacturers standard.
- .3 Finish:
- .1 Two coats alkyd baked enamel. Colour as indicated in Section 09 06 06.

3. EXECUTION

3.1 Examination

- .1 Examine walls, floors, and support bases for compliance with requirements for installation
tolerances and other conditions affecting performance of work.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation of Lockers

- .1 Co-ordinate installation of lockers with bases provided by others. Ensure all work on bases is
complete prior to beginning any installation.

- .2 Assemble and install lockers in accordance with manufacturer's written instructions level, plumb, and true; shim as required, using concealed shims.
- .3 Align locker units in groups, securing together using pop rivets or other approved vandal-resistant fasteners. Exposed nuts/bolt fastening not acceptable.
- .4 Securely fasten lockers to grounds and nailing strips.
- .5 Install finished end panels to exposed ends of locker banks.
- .6 Install locker numbers.

3.3 Adjusting, Cleaning, and Protection

- .1 Clean, lubricate, and adjust hardware.
- .2 Adjust doors and latches to operate easily without binding.
- .3 Protect metal lockers from damage, abuse, dust, dirt, stain, or paint.
- .4 Do not permit metal locker use during construction.
- .5 Touch up marred finishes, or replace metal lockers that cannot be restored to factory finished appearance.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide ducted lab fumehoods in accordance with requirements of Contract Documents.
- .2 Section Includes:
 - .1 Bench-top High-Performance Laboratory Fume Hoods.
 - .2 Service fixtures (ie. water, gas, etc.) and electrical service fittings in fume hoods.
 - .3 Piping and wiring within service fittings, light fixtures, switches, and other electrical devices.
 - .4 Fume hood base support.
 - .5 Work Surfaces within fume hoods.
 - .6 Laboratory sinks and cup sinks in fume hoods.
 - .7 Filler panels and ceiling enclosures for fume hoods.
- .3 This specification covers the requirements for the purchase of bench mounted laboratory fume hoods for use with remote exhaust blower systems.
- .4 Bench-mounted laboratory fume hoods in 6 foot widths, internal depth of 27.2" and external depth of 37.7" is required.
- .5 This specification sets the intent for quality, performance and appearance.

1.2 Reference Standards

- .1 The laboratory hoods must conform to the following regulations and standards.
 - .1 SEFA 1, Scientific Equipment and Furniture Association, Recommended Practices for Laboratory Fume Hoods
 - .2 SEFA 8, Recommended Practices for Laboratory Grade Metal Casework, 8.0 Cabinet Surface Finish Tests
 - .3 NFPA 45, National Fire Protection Association, Fire Protection for Laboratories Using Chemicals
 - .4 ASTM E84-09C, ANSI 2.5, NFPA 255, UL 723, UBC 8-1 (42-1), Standard Test method for Surface Burning Characteristics of Building Materials
 - .5 ASHRAE 110, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Method of Testing Performance of Laboratory Fume Hoods
 - .6 ANSI/AIHA Z9.5, American Industrial Hygiene Association, Laboratory Ventilation
 - .7 OSHA, Federal Register 29 CFR Part 1910, Occupational Safety & Health Administration, U.S. Department of Labor, Occupational exposures to hazardous chemicals in laboratories.
- .2 The laboratory fume hoods must carry the ETL listed mark for the following.
 - .1 UL 61010-1 (formerly 3101-1), Underwriters Laboratories Inc., Electrical Equipment for Laboratory Use
 - .2 CAN/CSA C22.2 No. 61010-1, Canadian Standards Association, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use
 - .3 UL 1805, Underwriters Laboratories Inc., Standard for Laboratory Hoods and Cabinets

1.3 Submittals

- .1 Action Submittals
 - .1 Laboratory hood specification sheets and product manuals shall be submitted by the hood manufacturer upon request, and include safe and proper operation and maintenance information.

- .2 Shop Drawings: Include plans, elevations, sections, and details.
 - .1 Indicate details for anchoring fume hoods to permanent building construction including locations of blocking and other supports.
 - .2 Indicate locations and types of service fittings together with associated service supply connection required.
 - .3 Indicate duct connections, electrical connections, and locations of access panels.
 - .4 Include roughing-in information for mechanical, plumbing, and electrical connections.
 - .5 Provide face opening, volumetric rates, and static pressure drop data.
- .3 Submit a document detailing the information supplied on the Hood Safety Practices Label to verify compliance to specifications.
- .2 Informational Submittals
 - .1 Product Test Reports: Showing compliance with specified performance requirements, including NEBB representative test report as defined previously.
 - .2 Independent validation:
 - .1 Written verification that the laboratory fume hoods carry the ETL listed mark for the following.
 - UL 61010-1 (formerly 3101-1), Underwriters Laboratories Inc., Electrical Equipment for Laboratory Use
 - CAN/CSA C22.2 No. 61010-1, Canadian Standards Association, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use
 - UL 1805, Underwriters Laboratories Inc., Standard for Laboratory Hoods and Cabinets
 - .2 Written verification that 230 volt model fume hoods carry the CE conformity marking as required by the Council of European Communities.
 - .3 Written verification from an outside testing agency confirming coating compliance to SEFA 8-2010, Recommended Practices for Laboratory Grade Metal Casework, 8.0 Cabinet Surface Finish Tests
 - .3 Documentation of ISO 9001 Certified manufacturing plant and processes.
 - .4 List of five installations (of equal or larger size and requirements) is available upon request. Provide contact at each.
 - .5 Declaration of Made in America. Owner reserves the right to evaluate Made in America claims for compliance with the Bureau of Consumer Protection.
- .3 Material Submittals
 - .1 Samples for Verification: of the hood exterior wall material, interior liner and baffle material, epoxy work surface material, and color selection chips are available from the hood manufacturer upon request.
- 1.4 Quality Assurance
 - .1 Fume hoods shall be designed, including comprehensive engineering analysis, by a qualified, licensed Professional Engineer.
 - .2 Manufacturer's Qualifications
 - .1 ISO 9001 Certified manufacturing plant and processes.
 - .2 Ten installations of equal or larger size and requirements. Provide contact at each.
 - .3 Only hood manufacturers who have had fume hoods as a principal product for 50 years are considered.
 - .3 Fume hoods shall be **Made in America**
 - .1 95% or more of raw material and component suppliers shall be United States based.

- .2 Stainless and cold rolled steel used in manufacturing shall be sourced from United States steel mills.
- .3 Final product must be fabricated and assembled within the United States of America.
- .4 Owner reserves the right to evaluate Made in America claims for compliance with the Bureau of Consumer Protection.

- .4 Supply all equipment in accordance with this specification. Offering a product differing in materials, construction, or performance from this specification requires written approval obtained seven days or more before the proposal deadline.

- .5 The owner/architect reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.

- .6 Manufacturer's warranty against defects in material or workmanship on its fume hoods will be for 1 year from date of installation or 2 years from date of purchase, whichever is sooner, and includes replacement of parts (except lamps) and labor.

- 1.5 Delivery, Storage And Handling
 - .1 Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.
 - .2 Schedule delivery of equipment so that spaces are sufficiently complete that equipment can be installed immediately following delivery.

- 1.6 Project Conditions
 - .1 Environmental Limitations: Do not deliver or install fume hoods until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

2. PRODUCTS

2.1 Performance Requirements

- .1 General Design Requirements
 - .1 Fume hoods shall function as ventilated, enclosed workspaces, designed to capture, contain and exhaust fumes, vapors and particulate matter produced or generated within the enclosure.
 - .2 Fume hood shall be factory designed to function as a variable air volume fume hood without modification.
 - .3 Structure and Materials of construction
 - .1 Hoods are of double-wall construction
 - .2 Powder-coated, cold rolled steel exterior
 - .3 Galvanized steel support members
 - .4 Sheet molded composite panel internal liner
 - .4 Baffles
 - .1 Perforated primary baffle designed to pull air in horizontal streams to minimize the air roll pattern associated with traditional fume hoods.
 - .2 Baffle slot pattern designed to optimize face velocity profile.
 - .3 A secondary baffle is located behind the primary perforated baffle to counteract upward air streams that produce roll.
 - .4 Moving or adjustable baffles are not acceptable
 - .5 Sash
 - .1 Maximum opening is 28".
 - .2 Unobstructed viewing height is 37.5".

- .3 Hood incorporates a perforated sash handle to bleed air into the hood chamber directing fume concentrations away from the user's breathing zone.
- .6 Airfoil:
 - .1 Hoods are provided with an airfoil across the bottom of the sash area that allows airflow into the hood regardless of user's position.
- .7 Hoods are provided with an upper dilution air supply for by-pass air to bathe the sash interior and upper interior and to provide 5-10% of the hood's air volume requirements.
- .8 Besides the exhaust blower, no additional blowers are required for specified containment.
- .9 Access for maintenance is from both the front, interior, and exterior sides of the hood.
- .10 Services:
 - .1 Hood manufacturer shall furnish and deliver all service outlets, accessory fittings, electrical receptacles and switches, as listed in these specifications, equipment schedules or as shown on drawings.
 - .2 Plumbing fittings mounted on the fume hood superstructures shall be pre-plumbed per section 2.03.
 - .3 Final plumbing and electrical connections are the responsibility of those contractors fulfilling requirements of Divisions 22, 23 and 26.
 - .4 All electrical services are pre-wired to a single point internal junction box at the top right of the hood.
- .11 Hoods without service fixtures must pass through a 38" opening without disassembly.
- .2 Containment
 - .1 The purpose of this section is to set a standard of performance for the bidder's laboratory fume hood before award of contract, and may not necessarily represent the operating conditions of the hoods after installation. Before or after award of contract, owners may require representative witness to said testing at their option, with failure to meet passing criteria as grounds for rejection of the bidder. Test data shall be provided at no cost to the owner.
 - .2 Evaluation of manufacturer's standard product shall take place in manufacturer's test facility meeting the following criteria.
 - .1 Lab to be located at manufacturer's place of business for the testing of bench-mounted laboratory hoods in accordance with ASHRAE Standard 110.
 - .2 Room shall accommodate hoods up to 16' wide, while maintaining sufficient area so that a minimum of 15 feet of clear space is available in front of and 5' on both sides of hoods for viewing tests.
 - .3 The facility's ventilation system shall have adequate heating and air conditioning so that room air temperatures can be maintained within the desired ranges.
 - .4 One hundred percent non-recirculated air to be both carbon and HEPA filtered to ensure removal of contaminants that could interfere with containment testing before entering the lab.
 - .5 Make-up air to the test room shall be ceiling-supplied through any combination of multiple diffusers to either minimize adverse airflow, or increase it depending on test objectives.
 - .6 Exhaust volumes shall be computer controlled and measured via AMCA calibrated orifices and flow station at each exhaust trunk.
 - .7 Room pressurization must be digitally monitored, and variable depending on test objectives.
 - .8 All equipment must be properly calibrated.
 - .9 Qualified personnel familiar with the laboratory and its operation shall be available to perform the test.
 - .10 Include the following instrumentation and test equipment:
 - Properly calibrated hot wire thermal anemometer capable of measuring air velocities from 10 to 600 ft/minute; correlate with computer data acquisition format to provide simultaneous readings at all points.
 - Theatrical smoke generator or other source of high volume smoke.
 - Smoke tubes or other source of localized smoke.

- Leakmeter with traceable calibration, calibrated just before test, to indicated concentration of sulfur hexafluoride.
 - Tracer gas: Sulfur hexafluoride supplied from a cylinder with two stage regulator.
 - Adjustable mannequin, 5' 0" to 5'8" in height, with reasonable human proportions, clothed in a smock
 - Inclined manometer with graduations no greater than 0.2 inch of water.
 - Ejector system: Tracer gas ejector built to specific ASHRAE-110 requirements.
 - Critical orifice: Sized to provide tracer gas at four or eight liters per minute at an upstream pressure sufficient to maintain release rate.
 - Data acquisition software to include HoodPro™ and LabMeasurePro™ from Exposure Control Technologies, Inc.
- .3 Hood shall be tested to ASHRAE 110 modified test method as detailed below.
- .4 Some fume hoods may use face velocity controls, motorized baffles, integral auxiliary make up, or supply fans. Because all of these devices are subject to failure, containment testing shall show both operational containment and product containment with these systems off.
- .5 Fume hood sashes shall be placed in their full open position, at least 28" from the work surface, unless noted otherwise.
- .6 Ambient Temperature: 68 to 74 degrees F
- .7 **Average Face Velocity:** Face velocity average shall be 40 and 50fpm, as noted below, plus or minus 5%.
- .1 An imaginary grid is formed comprised of equal 12" by 12" squares, or smaller, across the face opening of the laboratory hood. Airflow velocity readings are taken at the intersections of these grids with calibrated hot wire anemometer over a twenty second period of time. Probe shall communicate readings to a computer data acquisition package, which will provide an average of each reading over the 20 second time period, and also an overall average upon completion of data acquisition. Face velocity shall be determined by averaging readings at the hood face.
- .2 Average face velocity must be achieved without exceeding the CFM below.
- .8 **Tracer Gas Detection:** Hood shall achieve a rating of 4.0AM0.00 maximum average and 4.0AM0.01 maximum spike (unless specifically otherwise noted), wherein:
- .1 4.0 = tracer gas release in liters/minute, AM = as manufactured, 0.01 = tracer gas in parts per million (PPM)
- .2 With the ejector body 6" from the rear of the sash plane, the test shall be conducted for each ejector position noted.
- Left position with ejector 12" from the left interior wall.
 - Center position with ejector equidistant from the sidewalls.
 - Right position with ejector 12" from the right interior wall.
- .3 Install mannequin positioned in front of the hood, centered on the ejector.
- .4 Detector probes shall be placed 3" in front of the sash plane. The test shall be conducted for each detector probe position and corresponding face velocity.
- Detector probe in the region of the **nose and mouth of the mannequin**. Test with average face velocity of **40 fpm**.
 - With the mannequin height reduced 4", place detector probe in the **chest of the mannequin**, and even with the height of the ejector. Test with average face velocity of **50 fpm**.
- .5 Open tracer gas valve, and collect readings with a computer data acquisition package, which is capable of monitoring and visually recording a minimum of one reading per second for a minimal five minute time period for each position.
- .6 The single control rating of the fume hood shall be the results of the test position yielding the highest average levels of tracer gas in any of the six mannequin/ejector configurations.

- .7 With the ejector and mannequin in the center position, detector probe in the region of the **nose and mouth of the mannequin**, average face velocity of **40 fpm**, tracer gas released, and concentration recorded, open and close the sash in a smooth motion. Test to be repeated three times, with peak values of 0.01 PPM or less.
- .8 With the mannequin removed, the periphery of the hood is traversed by the probe at 1" in front of the hood opening at a rate of 3 inches per second. The hood shall have a maximum perimeter reading of 0.01 PPM or less.
- .9 Flow Visualization:
 - .1 Test the operation of the lower air bypass airflow opening and hood periphery by introducing light smoke under the airfoil, and around the perimeter of the sash opening. If any smoke that enters the hood reverses directions and escapes from any of these locations, the hood fails this portion of the test and receives no rating.
 - .2 Introduce smoke along both walls and the hood floor in a line parallel to the hood face and 6 inches (152 mm) back into the hood. Define air movement toward the face of the hood as reverse airflow and define lack of movement as dead air space. All smoke should be carried to the back of the hood and out.
 - .3 Introduce a large volume of smoke at the work surface in the center of the hood, and 6" inside the plane of the sash. The smoke shall not get entrained in an interior vortex, and shall clear in a single pass.
- .10 All data on the above, including instrumentation and equipment, and test conditions shall be provided on a report, including the average face velocities, and a separate graph-type performance curve on all tracer gas tests for all required fume hood widths. Performance test data for a 6' representative hood shall be conducted by an independent testing agency and by a specific individual certified to perform such tests by the National Environmental Balancing Bureau (NEBB).
- .3 Efficiencies
 - .1 The fume hood shall maintain constant volumetric rate (+/- 5 CFM) and static pressure losses (+/- 0.01" H2O) across all sash positions. Without any modifications, the hood shall also maintain a sufficiently restricted by-pass for use with a variable air volume (VAV) system.
 - .2 The fume hood shall demonstrate a minimization of the volumetric rate of air (CFM) requirement at any given face velocity. Required CFM to achieve desired face velocity shall not exceed that which is noted in the chart below.
 - .3 The fume hood shall demonstrate a minimization of static pressure loss (inches of H2O) at any given CFM. Static pressure loss at desired face velocity, and corresponding CFM, shall not exceed that which is noted in the chart below.

Face Velocity (fpm) Sash at 28" open	Airflow Volumetric Rate (CFM) @ Static Pressure (inches of water)			
	4' Hood	5' Hood	6' Hood	8' Hood
100	705, 0.26"	930, 0.32"	1150, 0.41"	1600, 0.29"
80	565, 0.17"	745, 0.20"	920, 0.25"	1280, 0.19"
60	425, 0.09"	560, 0.12"	690, 0.15"	960, 0.10"
50*	350, 0.06"	465, 0.08"	575, 0.10"	800, 0.07"
40*	280, 0.04"	370, 0.05"	460, 0.07"	640, 0.05"
Face Velocity (fpm) Sash at 18" open	Airflow Volumetric Rate (CFM) @ Static Pressure (inches of water)			
	4' Hood	5' Hood	6' Hood	8' Hood
100	440, 0.10"	580, 0.12"	720, 0.16"	1000, 0.11"
80	350, 0.06"	465, 0.08"	575, 0.10"	800, 0.07"
60	265, 0.04"	350, 0.05"	430, 0.06"	600, 0.04"

*There is not a written standard that would suggest a design face velocity below 60 fpm. This data is for informational purposes only.

- .4 Noise Criterion: The hood shall have a Noise Criterion (NC) rating of less than 50; measured 36" in front of the hood with full open sash, at 100 fpm face velocity. NC is a factor of sound pressure level (dB) and frequency.
- .5 Illumination: Shall be a minimum average of 80 foot-candles inside the work area. Work area is defined as the area inside the lined portion of the fume hood, from the face of baffle to sash plane, from interior left to interior right, and from the work surface to a height of 28 inches.
- .6 Materials of Construction: Interior and Exterior materials of construction and finishes shall meet the requirements below.

2.2 Manufacturers

- .1 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 Labconco Corporation, supplied by Canadian Scientific Lab Systems Inc.

2.3 Materials

- .1 Basis-of-Design: Labconco Protector XStream 6-foot wide

2.4 Hood Interior Liner And Baffle

- .1 Liner material must comply with UL 1805, and be listed within NRTL test report as proof of compliance.
- .2 General Material Properties
 - .1 Nonflammable, corrosion and chemical-resistant
 - .2 Sheet molded homogenous polyester panels
 - .3 Minimum thickness is 3/16"
 - .4 Smooth, white finish
- .3 Mechanical Properties
 - .1 Tensile Strength: 7,500 PSI (51.7 Mpa)
 - .2 Tensile Modulus: 1.7×10^6 PSI (11,700 Mpa)
 - .3 Flexural Strength: 21,000 PSI (145 Mpa)
 - .4 Flexural Strength at 130 degrees C: 12,900 PSI (89 Mpa)
 - .5 Compressive Strength: 32,500 PSI (224 Mpa)
 - .6 IZOD Impact Strength (Notched): 8.4 Ft Lb/in (4.5 J/cm)
- .4 Flame and Smoke Characteristics
 - .1 Flame retardant, self-extinguishing, with a flame spread rating of 25 or less in accordance with ASTM-E84
 - .2 Oxygen Index: 35%
 - .3 Smoke Density: 115
- .5 Physical Properties
 - .1 Water Absorption: 0.4%
 - .2 Specific Gravity: 4.81
 - .3 Coefficient of Thermal Expansion: 2 In/in/ degree C $\times 10^{-5}$
 - .4 Thermal Conductivity: 1.9 BTU/Hr/Ft²/In/degree F
- .6 Chemical Resistance
 - .1 Splash and Spill Resistance:

- .1 Suspend sample panel in a vertical plane
- .2 Apply five drops of each reagent listed with an eyedropper
- .3 Apply liquid reagents at top of panel and allow to flow down full panel height
- .2 Fume Resistance:
 - .1 Place 25 milliliters of reagent into 100 milliliters beakers and position panel over beaker tops in the proper sequence. Ensure beaker pouring lip permits air to enter the interior atmosphere.
 - .2 After 24 hours remove panel, flush with water, clean with detergent, rinse, wipe dry and evaluate
- .3 Evaluation ratings: Change in surface finish and function shall be described by the following numerical ratings
 - .1 No Effect: No change in color or gloss
 - .2 Excellent: Slight detectable change in color or gloss, but no change to the function or life of the work surface material
 - .3 Good: Clearly discernible change in color or gloss, but no significant impairment of function or life
 - .4 Fair: Objectionable change in appearance due to surface discoloration or etch, possibly resulting in deterioration of function over an extended period
 - .5 Failure: Pitting, cratering or erosion of work surface material; obvious and significant deterioration
- .4 Required minimum results for each reagent (Reagent: Fume Resistance Rating, Splash and Spill Resistance Rating)
 - .1 Hydrochloric Acid (37%): 2,1
 - .2 Sulfuric Acid (33%): 2,1
 - .3 Sulfuric Acid (77%): 1,1
 - .4 Sulfuric Acid (96%): 1,2
 - .5 Formic Acid (90%): 2,1
 - .6 Nitric Acid (20%): 2,2
 - .7 Nitric Acid (30%): 1,2
 - .8 Nitric Acid (70%): 3,2
 - .9 Hydrofluoric Acid (48%): 2,2
 - .10 Phosphoric Acid (85%): 1,1
 - .11 Chromic Acid (60%): 1,4
 - .12 Acetic Acid (98%): 1,1
 - .13 Ammonium Hydroxide (20%): 1,1
 - .14 Sodium Hydroxide (10%): 1,1
 - .15 Sodium Hydroxide (20%): 1,3
 - .16 Sodium Hydroxide (40%): 1,3
 - .17 Sodium Hydroxide Flake: 1,-
 - .18 Sodium Sulfide: 1,1
 - .19 Zinc Chloride: 2,1
 - .20 Tincture of Iodine: 3,3
 - .21 Silver Nitrate: 2,1
 - .22 Methyl Alcohol: 1,1
 - .23 Ethyl Alcohol: 1,1
 - .24 Butyl Alcohol: 1,1
 - .25 Benzene: 1,1
 - .26 Xylene: 1,1
 - .27 Toluene: 1,1
 - .28 Gasoline: 1,1
 - .29 Dichloro Acetic Acid: 2,2
 - .30 Dimethyl Formamide: 2,2
 - .31 Ethyl Acetate: 1,1
 - .32 Amyl Acetate: 1,1
 - .33 Acetone: 1,1
 - .34 Chloroform: 1,1
 - .35 Carbon Tetrachloride: 1,1
 - .36 Phenol: 2,2
 - .37 Cresol: 1,1

.38	Formaldehyde:	1,1
.39	Trichloroethylene:	1,1
.40	Ethyl Ether:	1,1
.41	Furfural:	1,3
.42	Methylene Chloride:	1,1
.43	Mono Chloro Benzene:	1,1
.44	Dioxane:	1,1
.45	Methyl Ethyl Ketone:	1,1
.46	Acid Dichromate:	1,2
.47	Hydrogen Peroxide:	1,1
.48	Napthalene:	1,1

.7 Sheet Steel

- .1 Side panels and access panels 20-gauge (or heavier) sheet steel.
- .2 Hood corner posts are 18-gauge sheet steel.
- .3 Ceiling enclosure panels are 18 gauge sheet steel.
- .4 Cold-rolled, commercial steel (CS) sheet, complying with ASTM A 1008/A 1008M.

.8 Chemical Resistant Finish

- .1 General: Prepare, treat, and finish welded assemblies after welding. Prepare, treat, and finish components that are to be assembled with mechanical fasteners before assembling.
- .2 Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Third party validation required.
- .3 Powder-coat process required. Paint processes that release Volatile Organic Compounds (VOC) are not acceptable
- .4 Color for Fume Hood Finish: Glacier White

.9 Safety Glass

- .1 Tempered
 - .1 Clarity and temper test to be as specified in latest edition of Glass Tempering Association, *Engineering Standards Manual*, Section 8.1.
 - .2 Surface and interior visible quality to be as specified per ASTM C 1036, *Standard Specification for Flat Glass*, Table 4, Quality level Q3.

2.5 Construction

.1 Superstructure:

- .1 Self-supporting, rigid structural assembly, to support inner wall consisting of fume hood liner and outer wall of sheet metal exterior.
- .2 Fabricated from galvanized steel.
- .3 Space shall accommodate fume hood wiring and plumbing components for service fixtures.
- .4 Access to fixture valves concealed in wall provided by exterior removable access panels, gasket access panels on the inside liner walls, or through removable access panels on the front posts.

.2 Exterior

- .1 Fabricate from steel sheet with component parts screwed together.
- .2 Apply chemical-resistant finish to interior and exterior surfaces of component parts before assembly.
- .3 Interchangeable side panels shall lift off without the use of tools to allow access to plumbing lines, service fittings, electrical wiring, counterbalance sash weights, and light fixtures. Exposed fasteners or hardware, and Velcro type fasteners, are not acceptable.
- .4 Corner posts
 - .1 Pre-punched and plugged to accommodate up to 4 service fixtures per side

- .2 All services are accessible from the front of the hood.
- .3 Aerodynamic shape
- .4 Accommodate two electrical duplexes per side.
- .5 Right hand corner post includes electrical switches and pre-cut for Airflow monitor installation.
- .6 Un-used penetrations shall be plugged.
- .5 Top and sides of face opening to provide an aerodynamic shape to ensure smooth, even flow of air into fume hood.
- .6 Panel above header shall be removable without the use of tools to allow access to mechanical connection, electrical wiring, counterbalance sash weights, and light fixtures. Exposed fasteners or hardware, and Velcro type fasteners, are not acceptable.
- .3 Dimensions
 - .1 Overall exterior dimensions: 6 foot nominal width: 72" w x 59" h x 37.7" d
 - .2 Overall interior dimensions: 6 foot nominal width: 62.1" w x 48" h x 27.2" d
- .4 Hood Liner
 - .1 Adhere interior liner components to superstructure.
 - .2 Stainless steel fasteners shall be used on the interior ceiling for structural integrity.
 - .3 Fasteners exposed to chemical environment are not acceptable.
 - .4 Punch fume hood lining side panels to receive four service fittings, for use with remote controls, per side. Provide removable plug buttons for holes not used for indicated fittings.
 - .5 Each side wall shall include an oval interior access panel to provide access to the side wall of the fume hood for plumbing service access. Access panel material shall be that of the liner, and gasketed to form a vapor proof seal.
- .5 Hood Baffle
 - .1 Baffle system shall be designed to optimize the face velocity profile, and to capture a wide range of gaseous densities without adjustment or moving components.
 - .2 Include a two-baffle system.
 - .1 Primary baffle: Shall provide a continuous horizontal slot at the work surface. Baffle panels shall have multiple horizontal slots, with a chamfered entry. Slot pattern shall be proven to optimize face velocity profile, and direct air in a non-turbulent/laminar flow stream from the hood face into the baffle in a single pass.
 - .2 Secondary baffle: located between the primary baffle and the back wall of the hood, neutralizes any upward air streams and reduce air stream roll.
 - .3 The baffle system shall be constructed with the same material as the fume hood liner.
 - .4 The baffles shall be removable for cleaning. The primary baffles shall be two pieces to allow removal without the use of tools.
 - .5 Exposed components to be non-metallic. Metal components exposed to chemical environment are not acceptable.
 - .6 Moving parts or adjustment of any kind is not acceptable.
- .6 Exhaust Connection
 - .1 316 stainless steel with Chemical-Resistant Finish
 - .2 12.81" ID to accommodate any 12" nominal duct without the need for a transition adapter. 4, 5, and 6-foot hoods have one exhaust connection, and 8-foot hoods have two exhaust connections. Additional components required to accommodate 12" nominal mechanical system are not acceptable.
 - .3 Ducting shall go inside the duct collar to ensure condensate travels into the hood and evaporates. Duct collars that allow duct connection over the collar are not acceptable.
- .7 Airfoil
 - .1 Cold Rolled Steel with Chemical-Resistant Finish.

- .2 Airfoil shall have an aerodynamic radius to sweep the air into the hood with minimal turbulence. Airfoil directs airflow across work top to remove heavier-than-air gases.
 - .3 Must have 5 rows of perforations to allow the air to bypass underneath and through the foil and sweep across the work surface to prevent any back flow of fumes escaping from the front of the hood opening. This airflow continues even if blocked by the presence of the operator.
 - .4 Foil must extend back under the sash to prevent closure of the lower by-pass opening when the sash is in the fully closed position, directly on top of the airfoil.
- .8 Sash Assembly
- .1 Glass: Fully tempered safety glass with unobstructed, side-to-side view of fume hood interior and service fixture connections.
 - .2 Dimensions: The full sash opening height is 28", the total unobstructed viewing height is 37.5" measured from the work surface.
 - .3 Sash Tracks: Steel with Chemical Resistant Finish. Shall include bump stops for opening and closing.
 - .4 Sash Handle: extruded aluminum with Chemical Resistant Finish. Sash handle includes a perforated air passage directly atop the handle to bleed air into the hood chamber and direct chemical fumes away from the user's breathing zone. The handle is ergonomic in design and is easy to grasp when operating
 - .5 Sash guides: Corrosion resistant extruded poly-vinyl chloride.
 - .6 Sash System
 - .1 Vertical Sash (Cable and Pulley)
 - Hoods have a single vertical sash counterbalanced by a single weight.
 - Sash and weight to be connected via aircraft cable meeting MIL-W-83420 Military Specification.
 - Rear pulleys shall be connected via timing shaft to prevent sash tilting and permit one finger operation at any point along full width sash handle. Maximum 7 pounds pull required to raise or lower sash throughout its full length of travel.
 - Design system to hold sash at any position without creep and to prevent sash drop in the event of cable failure.
 - Include a defeatable, and automatically resetting sash stop positioned for an 18" sash height.
- .9 Electrical Components
- .1 Lighting
 - .1 Provide UL Listed, high-efficiency, quick-start, LED lighting systems, including bulbs.
 - 5 Foot Hoods - 2 each, 4-foot 17-watt LED lamps
 - 6 Foot Hoods - 2 each, 4-foot 17-watt LED lamps
 - .2 Vapor-Proof: all electrical components shall be outside of the contaminated air space. Lighting shall be located behind a laminated safety glass shield, sealed to the top of the hood liner.
 - .3 The LED light assemblies shall be serviceable from outside the fume hood cavity, without the use of tools.
 - .4 Light switch to be included on the lower right corner post, at heights compliant with the Americans with Disabilities Act (ADA).
 - .2 Blower Switch
 - .1 Hoods shall be provided with blower switch, on the lower right corner post, at heights compliant with the Americans with Disabilities Act (ADA).
 - .3 Electrical Receptacles

- .1 The hoods shall accommodate up to four (two per corner post) electrical receptacles as indicated in schedule or drawings. Receptacles to be 115 volt, 60 Hz, three-wire polarized and grounded electrical duplex, with Ground Fault Circuit Interruption (GFCI)
- .2 Receptacles shall be individually wired to field wiring box, and each rated at 20 Amperes.
- .3 Cover plates shall be acid resistant thermoplastic.
- .4 Wiring
 - .1 Every electrical component shall be individually wired to a single point internal field wiring box (including individual duplexes/receptacles).
 - .2 Field wiring box to be 7" x 4" x 2.5", grounded, and have (12) 7/8" diameter knock out penetrations.
 - .3 Final wiring and circuit dedication is to be by others.
 - .4 Each receptacle circuit shall accommodate being wired to a dedicated building circuit rated at 20A, or the receptacles wired to a single circuit with the total load not exceeding 20 Amperes.
- .5 Fume hood to have third party validation of compliance to UL 1805 and UL 61010-1 by a Nationally Recognized Testing Laboratory (NRTL)
- .10 Upper Dilution Air Supply
 - .1 Located behind and above the sash to introduce between 5 and 10% of the required hood air volume, and maintain sufficient exhaust air volume through hood to adequately dilute hazardous fumes regardless of sash position.
 - .2 This device bathes the sash interior above the work area to eliminate chemical fumes along the sash plane near the operator's critical breathing zone.
 - .3 Shall act as a by-pass opening controlled by sash position. If on a constant volume mechanical system, the hood shall not have a change in static pressure or exhaust volume across all sash positions.
 - .4 Shall offer a significant restriction to the by-pass opening to allow the use of a VAV mechanical system without modification to the by-pass opening.
- .11 Hood Safety Practices Label: Corrosion resistant plate attached to the left corner post of the fume hood with the following Hood Safety Practices:
 - .1 For use with substances that produce hazardous levels of airborne chemicals: gas, fumes, vapors, dust
 - .2 Do not put your head in the hood.
 - .3 Minimize drafts and sudden movements in front of the hood.
 - .4 Work a minimum of six inches inside the hood.
 - .5 Elevate equipment above the work surface.
 - .6 Keep sill and baffle unobstructed.
 - .7 Do not use the hood for storage.
 - .8 Adjust the sash to smallest opening possible when in use.
 - .9 Close sash when unattended.
 - .10 Do not remove any of the hood components.
 - .11 Do not place flammable solvents near heat, flame or sparks.
 - .12 Do not evaporate large amounts of flammable liquids.
 - .13 Wipe up spills immediately.
 - .14 Routinely validate airflow.
 - .15 If the ventilation system malfunctions, or airflow alarm indicates unsafe condition, close sash and discontinue hood operation immediately-call for help.
 - .16 Do not use with Biohazards and Perchloric Acid
- .12 Fume Hood Accessories
 - .1 Service Fixtures: Color-coded hose nozzle outlets and valves mounted inside the fume hood and controlled from the exterior with color-coded index handles
 - .1 The hoods are equipped without service fixtures or will be provided with a total of up to 8 service fixtures as indicated in schedule.

- .2 Hose connectors located inside the fume hood cavity are chemically-resistant, glass-filled polypropylene with 6 serrations.
- .3 Service lines shall be factory installed from valve to outlet
 - Copper tubing unless otherwise noted
 - Brass service lines for gas
 - Stainless steel service lines for Deionized Water
 - Connections shall be made with quick-connect compression fittings on the inlet and outlet of the valve body, soldered and brazed connections not easily disassembled are not acceptable.
 - Services pre-piped to the top of the hood.
- .4 Valves
 - Extruded brass valve and rotating seat, TFE-coated silicone bronze stem and TFE packing.
 - Fixture handles are plastic and color coded as well as labeled for the designated type of service.
 - Fixtures are rated at maximum pressure of 200 psi.
 - Coefficient of flow for the valve, Cv=0.43.
 - Valves are front loaded, located on the fume hood corner post for remote use, and include:
 - Hot and cold tap water (confirm location during shop drawing review, side to match cup sink)
 - Vacuum
 - Nitrogen (for future use)
- .2 Tissue Screen: Provide epoxy-coated, stainless-steel screen at bottom baffle opening to prevent paper from being drawn into the exhaust plenum behind baffles.
- .3 Rear Finish Panel: Shall be the same materials and coating as the hood exterior.
- .4 Ceiling Enclosure Panels:
 - .1 Provide filler panels matching fume hood exterior to enclose space above fume hoods at front and sides of fume hoods and extending from tops of fume hoods to ceiling.
 - .2 Exposed fasteners are not acceptable.
 - .3 Height adjustment to be within the following ranges as specified in the schedule.
 - 11.0 - 14.0"
 - 14.0 – 18.6"
 - 18.6 – 24.4"
- .5 Distillation Grid: Include stainless steel rods, connectors, and factory drilled liner.
- .6 Face Velocity Monitor/Alarm
 - .1 Variable Air Volume (VAV) Prepared
 - Fume hoods shall come factory prepared with the proper cutouts and brackets to field mount specified VAV controller and sash position sensor as per section 25 30 02 – Field Control Devices.
- .13 Work Surface
 - .1 1.25" thick, molded from solid modified epoxy resin, with smooth, non-specular, black finish.
 - .2 One inch radius front edge for optimal fume hood performance.
 - .3 3/8" dished area to match the fume hood interior work space and form a water tight pan for spill containment.
 - .4 Include a 2.5" diameter hole on each side for service pass-through and piping. Hole to be covered by hood superstructure upon installation.
 - .5 Include two 1.5" diameter penetrations to accommodate base cabinet venting. Holes to be located outside of dished area and under the fume hood baffles. Include plugs.
 - .6 Physical Properties:
 - .1 Flexural Strength: Not less than 10,000 psi (70 MPa).
 - .2 Modulus of Elasticity: Not less than 2,000,000 psi (1400 MPa).

- .3 Hardness (Rockwell M): Not less than 100.
- .4 Water Absorption (24 Hours): Not more than 0.02 percent.
- .5 Heat Distortion Point: Not less than 260 deg F (127 deg C).
- .6 Flame-Spread Index: 25 or less per ASTM E 84.
- .7 Cupsink
 - .1 3 x 6" dimension, polypropylene construction
 - .2 Provide with strainers and tailpieces, NPS 1-1/2 (DN 40)
 - .3 To sit flush with dished area of work surface
 - .4 Cupsink(s) to be located in rear right or left (confirm location during shop drawing review).
- .14 Supporting Base Cabinets
 - .1 Base cabinets shall be in depths of 22", widths, quantities, and types called out in the equipment **drawings**, and meet the requirements of this specification.
 - .2 Construction requirements for all cabinets
 - .1 Exterior construction is 18 gauge (or heavier) cold rolled sheet steel with Chemical Resistant Finish.
 - .2 Hinges are 10 gauge (or heavier) plate with self-clinching pilot pin. Knuckle, bullet, or piano type hinges are not accepted.
 - .3 The rear panel will feature a 12" x 8" removable plumbing access panel.
 - .4 Units 24" wide or less have only one door.
 - .5 Each cabinet includes four leveling feet.
 - .6 Capable of supporting up to 800 pounds.
 - .7 A 14" filler panel is required to increase the cabinet depth to 36".
 - .3 Standard Storage
 - .1 Overall exterior dimensions: 18" 18" w x 20" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - .2 Pull handles are stainless steel.
 - .4 Acid Storage
 - .1 Overall exterior dimensions: 18" 18" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - .2 Completely lined with a polyethylene corrosion resistant liner. The liner is 3/16" thick, with a vacuum formed PVC liner pan at the bottom to contain spills. Each door has a 3/16" sheet polyethylene liner.
 - .3 The cabinet is labeled: "ACID".
 - .4 Pull handles are stainless steel.
 - .5 Each cabinet is vented into the fume hood with a 1-1/2" vent pipe. It should provide a positive airflow directly into the fume hood exhaust system.
 - .6 Supply an epoxy coated steel shelf with PVC liner pan if indicated in the schedule.
 - .7 Acid cabinets with louvers are not acceptable
 - .8 Cabinets to have rear outlets (one high and one low) for ventilation.
 - .5 Solvent Storage
 - .1 Overall exterior dimensions: 18" 18" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - .2 Solvent storage cabinets are specifically designed for the storage of flammable and combustible liquids.
 - .3 Solvent Storage Cabinet must be compliant with NFPA 30 "Flammability and Combustible Liquids Code."
 - .4 Cabinets 30" wide and greater shall be tested and approved by Factory Mutual to meet Factory Mutual Approval Standard 6050.
 - .5 The bottoms, top, sides, and doors are fabricated of 18 gauge steel and are all double panel construction with a 1-1/2" air space between panels.
 - .6 All joints are welded or screwed to provide a rigid enclosure. A 2" deep liquid tight pan that covers the entire bottom of the cabinet is furnished to contain liquid leaks and spills.

- .7 A full-depth, 18 gauge steel, adjustable shelf is also provided. Shelves are sealed leak tight.
- .8 Two diametrically opposed flame arrestor vents with spark screens are provided in the back of the cabinet, as well as a grounding screw.
- .9 The cabinet has an interior finish same as the exterior.
- .10 The cabinet is labeled: "FLAMMABLE - KEEP FIRE AWAY".
- .11 The right hand door shall have a three point latching device.
- .12 Door handles include a key lock. Solvent storage handles are locking lever handles with bright chrome finish.
- .13 If noted on the schedule, self-closing/self-latching models shall be provided with a fusible-link feature to ensure the doors will close if the temperature outside the cabinet exceeds 165 degrees Fahrenheit. The doors are synchronized so that both doors will fully close.

3. EXECUTION

3.1 Examination

- .1 Examine areas, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.
- .2 Coordinate with other trades for the proper and correct installation of plumbing and electrical rough-in and for rough opening dimensions required for the installation of the hood.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

- .1 General: Install fume hoods according to shop drawings and manufacturer's written instructions.
- .2 Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework.
- .3 Securely attach access panels, but provide for easy removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- .4 Neighboring splash blocks shall not be attached directly to the hood.
- .5 Install according to standards required by authority having jurisdiction.
- .6 Sequence installations to ensure utility connections are achieved in an orderly and expeditious manner.
- .7 Touch up minor damaged surfaces caused by installation. Replace damaged components as directed by Architect.

3.3 Field Quality Control

- .1 NFPA 45 requires that fume hoods be field tested when installed.
- .2 Field test installed fume hoods according to ASHRAE 110-2016 to verify compliance with performance requirements.
 - .1 Adjust fume hoods, hood exhaust fans, building's HVAC system, and make other corrections until tested hoods perform as specified in fume hood schedule.
 - .2 After making corrections, retest fume hoods that failed to perform as specified.

3.4 Adjusting And Cleaning

- .1 Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.
- .2 Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- .3 Clean adjacent construction and surfaces that may have been soiled in the course of installation of work in this section.
- .4 Provide all necessary protective measures to prevent exposure of equipment and surfaces from exposure to other construction activity.
- .5 Advise contractor of procedures and precautions for protection of material and installed equipment and casework from damage by work of other trades.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: FILTERED (DUCTLESS) FUME HOODS

1. Bench-top Filtered Fume Hoods
2. Service fixtures (i.e. water, gas, etc.) and electrical service fittings in fume hoods.
3. Piping and wiring within service fittings, light fixtures, switches, and other electrical devices.
4. Fume hood base support.
5. Laboratory sinks and cup sinks in fume hoods.

B. Related Sections

1. Section 22 05 00 – Common Work Results for Plumbing: Furnish and installation of plumbing utilities and final connections to fume hoods.
2. Section 22 05 15 – Plumbing Specialties and Accessories: Furnishing and installation of acid neutralizing tank for fume hoods.
3. Section 22 11 16 – Domestic Water Piping: Furnishing and installation of domestic water connection to fume hood.
4. Section 22 13 18 – Drainage, Waste and Vent Piping – Plastic: Furnishing and installation of acid resistance DWV piping from fume hood.
5. Section 22 42 02 – Commercial Plumbing Fixtures: Furnishing and installation of plumbing fixtures and service connections for fume hood
 - a. Note cup sinks and service faucets integral to fume hood per the requirements of this section.
6. Section 26 05 00 – Common Work Results for Electrical: Furnishing and installation of electrical utilities and final connections to hoods.

1.02 SCOPE AND CLASSIFICATION

- A. This specification covers the requirements for the purchase of bench mounted filtered laboratory fume hoods.
- B. Bench-mounted laboratory filtered fume hoods in 6-foot wide, internal depth of 31.3”, and external depth of 37.7” is required.
- C. This specification sets the intent for quality, performance and appearance.

1.03 REFERENCES

- A. The laboratory hoods must conform to the following regulations and standard.
 1. SEFA 1-2010, Scientific Equipment and Furniture Association, Recommended Practices for Laboratory Fume Hoods.
 2. SEFA 9-2010, Recommended Practices for Ductless Enclosures (DH III)
 3. SEFA 8-2010, Recommended Practices for Laboratory Grade Metal Casework, 8.0 Cabinet Surface Finish Tests
 4. NFPA 45-2011, National Fire Protection Association, Fire Protection for Laboratories Using Chemicals

5. AFNOR NFX 15-211 Standard
6. ASHRAE 110-2016, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Method of Testing Performance of Laboratory Fume Hoods
7. ANSI/AIHA Z9.5-2011, American Industrial Hygiene Association, Laboratory Ventilation
8. OSHA, Federal Register 29 CFR Part 1910, Occupational Safety & Health Administration, U.S. Department of Labor, Occupational exposures to hazardous chemicals in laboratories.

B. The filtered fume hood will utilize UL listed components.

1.04 PERFORMANCE REQUIREMENTS

A. General Design Requirements (See Part 2 for details)

1. Fume hoods shall function as enclosed workspaces, designed to capture, contain and filter fumes, vapors and particulate matter produced or generated within the enclosure.
2. The filtered fume hood control module includes sash sensor to maintain 60 fpm face velocity with sash open to 16” sash opening height and a reduced blower RPM with the sash closed to enhance filtration and reduce noise
3. Structure and Materials of construction
 - a. Hoods are of double-wall construction
 - b. Powder-coated, cold rolled steel exterior
 - c. Galvanized steel support members
 - d. Interior liner made of:
 - 1) Fiberglass reinforced polyester sides and back
4. Baffles
 - a. Benchtop filtered fume hood shall have no baffles
5. Sash
 - a. Maximum opening is 28”.
 - b. Maximum operating height is 16” with manufacturer supplied sash stops.
 - c. Unobstructed viewing height is 37.5”
 - d. Hood incorporates a perforated sash handle to bleed air into the hood chamber directing fume concentrations away from the user’s breathing zone.
6. Airfoil:
 - a. Benchtop hoods are provided with an air foil across the bottom of the sash area to allow airflow into the hood regardless of user’s position.
7. No additional blowers are required for specified containment.
8. Access for maintenance is from both the front, interior and exterior sides of the hood.
9. Services:
 - a. Furnishing and delivering all service outlets, accessory fittings, electrical receptacles and switches, as listed in these specifications, equipment schedules or as shown on drawings.
 - b. Plumbing fittings mounted on the fume hood superstructures shall be pre-plumbed per section 2.03.
 - c. Final plumbing and electrical connections are the responsibility of those contractors fulfilling requirements of Divisions 22 and/or 26.
 - d. Two single-point junction boxes located at top left and top right provided for electrical duplex service wiring.
 - e. Hood comes prepared for electrical connection via hard wiring.
10. Hoods without service fixtures pass through a 38” opening without disassembly.

B. Containment & Safety

1. The purpose of this section is to set a standard of performance for the bidder's laboratory fume hood before aware of the contract, and may not necessarily represent the operating conditions of the hoods after installation. Before or after award of the contract, owners may require representative witness to said testing at their option, with failure to meet passing criteria as grounds for rejection of the bidder. Test data shall be provided at no cost to the owner.
2. Evaluation of the manufacturer's standard product shall take place in manufacturer's test facility meeting the following criteria.
 - a. Lab to be located at manufacturer's place of business for the testing of bench-mounted laboratory hoods in accordance with a modified ASHRAE 110 Standard using isopropyl alcohol.
 - b. Room shall accommodate hoods up to 16' wide, while maintaining sufficient area so that a minimum of 15 feet of clear space is available in front of and 5' on both sides of hoods for viewing tests.
 - c. The facility's ventilation system shall have adequate heating and air conditioning so that room air temperatures can be maintained within the desired range.
 - d. One hundred percent non-recirculated are to be both carbon and HEPA filtered to ensure removal of contaminants that could interfere with containment testing before entering the lab.
 - e. Make-up air to the test room shall be ceiling-supplied through any combination of multiple diffusers to either minimize adverse airflow, or increase it depending on test objectives.
 - f. Exhaust volumes shall be computer controlled and measured
 - g. Room pressurization must be digitally monitored, and variable depending on test objectives.
 - h. All equipment must be properly calibrated.
 - i. Qualified personnel familiar with the laboratory and its operation shall be available to perform the test.
 - j. Include the following instrumentation and test equipment:
 - 1) Properly calibrated hot wire thermal anemometer capable of measuring air velocities from 10 to 600 ft/minute correlate with computer data acquisition format to provide simultaneous readings at all points.
 - 2) Theatrical smoke generator or other source of high volume smoke.
 - 3) Smoke tubes or other source of localized smoke.
 - 4) Leak-meter with traceable calibration, calibrated just before test, to indicate concentration of sulfur hexafluoride (SF₆).
 - 5) Isopropyl Alcohol: Isopropyl Alcohol supplied from a bottle, 20ml, and poured in a pan 6" from sash.
 - 6) Adjustable mannequin, 5'0" to 5'8" in height, with reasonable human proportions, clothed in a laboratory smock
 - 7) Inclined manometer with graduations no greater than 0.2 inch of water.
3. Hood shall be tested to ASHRAE 110 modified test method as detailed below:
 - a. Fume hood sashes shall be placed in their full operating position, at least 16" from the work surface, unless noted otherwise.
 - b. Ambient Temperature: 68 to 74 degrees F
 - c. **Average Face Velocity:** Face velocity average shall be 60 fpm, as noted below in subsection 3.d, part 4 paragraphs a) and b), plus or minus 5%.
 - 1) An imaginary grid is formed comprised of equal 12" by 12" squares, or smaller, across the face opening of the laboratory hood. Airflow velocity readings are taken at the intersections of these grids with calibrated hot wire anemometer over a duration of twenty seconds. Probes shall communicate

- readings to a computer data acquisition package, which shall provide an average of each reading over that period and also an overall average upon completion of data acquisition. Face velocity shall be determined by averaging readings at the hood face.
- 2) Average face velocity must be achieved without any single point exceeding +/- 12 fpm (or 20%).
- d. **Tracer Gas Detection:** Hood shall achieve a rating of 4.0AM0.01 maximum average and 4.0AM0.10 maximum spike (unless specifically otherwise noted), wherein:
- 1) 4.0 = tracer gas release in liters/minute, AM = as manufactured, 0.01 = tracer gas in parts per million (ppm)
 - 2) With the isopropyl alcohol pan 6” from the rear of the sash plane, the test shall be conducted for each pan position noted.
 - i. Left position with pan 12” from the left interior wall.
 - ii. Center position with pan equidistant from the sidewalls.
 - iii. Right position with pan 12” from the right interior wall.
 - iv. Perimeter Scan
 - v. Sash movement effect
 - 3) Install mannequin positioned in front of the hood, centered on the ejector.
 - 4) Detector probes shall be placed 3” in front of the sash plane. The test shall be conducted for each detector probe position and corresponding face velocity.
 - i. Detector probe in the region of the **nose and mouth of the mannequin.**
Test with average face velocity of **60 fpm.**
 - 5) Collect readings with a computer data acquisition package, which is capable of monitoring and visually recording a minimum of one reading per second for a minimal five minute time period for each position.
 - 6) The single control rating of the fume hood shall be the results of the test position yielding the highest average levels of tracer gas in any of the six mannequin/ejector configurations.
 - 7) With the ejector and mannequin in the center position, detector probe in the region of the **nose and mouth of the mannequin**, average face velocity of **60 fpm**, tracer gas released, the concentration recorded, open and close the sash in a smooth motion. Test to be repeated three times, with peak values of 0.10 ppm or less.
 - 8) With the mannequin removed, the periphery of the hood is traversed by the probe at 1” in front of the hood opening at a rate of 3 inches per second. The hood shall have a maximum perimeter reading of 0.10 ppm or less.
- e. Flow visualization:
- 1) Test the operation of the lower air bypass airflow opening and hood periphery by introducing light smoke under the air foil, and around the perimeter of the sash opening. If any smoke that enters the hood reverses direction and escapes from any of these locations, the hood fails this portion of the test and receives no rating.
 - 2) Introduce smoke along both walls and the hood floor in a line parallel to the hood face and 6 inches (152 mm) back into the hood. Define air movement toward the face of the hood as reverse airflow and define lack of movement as dead air space. All smoke should be carried away from the face of the hood inward.
 - 3) Introduce a large volume of smoke at the work surface in the center of the hood, and 6 inches inside the plane of the sash. Define air movement toward the face of the hood as reverse airflow and define lack of movement as dead air space. All smoke should be carried away from the face of the hood inward.

- 4) All data on the above, including instruction and equipment and test conditions shall be provided on a report, including the average face velocities, and a separate graph-type performance curve on all tracer gas tests for all required fume hood widths. Performance test data for a 6 foot representative hood shall be conducted by an independent testing agency and by a specific individual certified to perform such tests by the National Environmental Balancing Bureau (NEBB).
4. Hood shall be tested in accordance with NIH testing modifications in conjunction with ASHRAE 110 methods as detailed below.
 - a. Hoods shall be tested with simulated apparatus. This apparatus shall consist of: two each 3.8 L round paint cans, one 300mm x 300mm x 300mm cardboard box, and three each 150mm x 150mm x 300mm cardboard boxes. These items shall be provided by the contractor and be positioned from 150mm to 250mm behind the sash, randomly distributed and supported off the work surface by 50mm x 50mm blocks.
 - b. The test gas for the tracer gas performance rating and sash movement performance tests shall be isopropyl alcohol in a pan.
 - c. The tracer gas and rapid walk-by test will be conducted only at the center position for the mannequin.
 - d. Test gas test duration for performance rating shall be five minutes.
 - e. At the conclusion of each 5-minute test, there will be three sash movement performance tests (also called rapid walk-by) at 300mm behind the mannequin. Each test shall be spaced 30 second apart.
 - f. There will be a minimum of three and a maximum of five people in the test room during the test procedure.
 - g. Test of alarm: shut off the fume hood exhaust or raise the sash above operational height and verify that the individual fume hood alarm activates.
 - h. Test individual controls: test any controls that are provided at the fume hood such as unoccupied cycle override, alarm override, etc...
 - i. Static test shall show an average tracer gas reading to not exceed 0.01ppm with no spikes above 0.01ppm.
 - j. Walk-by test shall show an average tracer gas reading to not exceed 0.01ppm with no spikes above 0.4ppm.
5. Hood shall be tested in accordance with modified ASHRAE 110 and with NIH modifications. Test reports available or in person witness.
6. Hood shall be tested to and surpass Standard AFNOR NF x 15-211 requirements
 - a. Filtration efficiency – defined by the filter capacity to retain noxious molecules manipulated within the enclosure and qualifies the quality of the recirculated air at the filter exhaust.
 - 1) Under normal operation, primary filtration shall control emission concentrations at the filter exhaust lower than 1% of the TLV
 - 2) Integrated detection methods must alert the user should the concentration at the filter exhaust exceed 1% of the TLV.
 - 3) Safety back up filtration must operate before the concentration at the exhaust of the primary filter reaches 50% of the TLV, and it's operational life must exceed 1/12 the life of the primary filter.
 - b. Containment efficiency – defined by the fume hood capacity to maintain chemical vapors or particles within the enclosure, without any propagation in the laboratory environment.
 - 1) Isopropyl Alcohol is to be generated inside the hood per modified ASHRAE 110 protocol.
 - 2) The maximum concentration of allowable gas at the measuring points is

- 0.1ppm.
- c. Air face velocity
 - 1) Hood must be capable of operating between 78 and 118 FPM at various sash height positions.
 - 2) Hood must be equipped with a permanent monitoring system for the air face velocity.
 - d. Documentation – Filtered fume hoods must be delivered with a booklet containing an exhaustive list of chemicals, certified by the manufacturer, that can be handled in the filtering fume hood in the conditions described (in accordance with AFNOR NF X 15-211). The following information must be indicated in the booklet for each chemical listed:
 - 1) The chemical name, formula, CAS number, boiling point, molecular weight, and saturation vapor pressure.
 - 2) The appropriate filter reference and its retention capacity during the primary filters life.
 - 3) The type of saturation detection system for the filter(s).
 - 4) The maximum quantity of the chemical that can be introduced within the hood.
 - 5) The name of the test laboratory having performed the test.
- C. Efficiencies
- 1. The fume hood shall maintain constant volumetric rate (+/- 5 CFM) and static pressure losses (+/- 0.01" H₂O) across all sash positions.
 - 2. The fume hood shall demonstrate a minimization of the volumetric rate of air (CFM) requirement at any given face velocity.
 - 3. The fume hood shall demonstrate a minimization of static pressure loss (inches of H₂O) at any given CFM.
- D. Sound Pressure: The hood shall have a sound pressure of less than 60 dB(A); measured 36" in front of the hood with the sash at 16" above the work surface, at 60 fpm face velocity and less than 48dB(A) with sash closed.
- E. Illumination: Shall be a minimum average of 63 foot-candles inside the work area. Work area is defined as the area inside the lined portion of the fume hood, from the face of the back wall liner to sash plane, from interior left to interior right, and from the work surface to a height of 28 inches.
- F. Materials of Construction: Interior and Exterior materials of construction and finishes shall meet the requirements in Part 2 of this specification.

1.05 QUALITY ASSURANCE

- A. Fume hoods shall be designed, including comprehensive engineering analysis, by a qualified, licensed Professional Engineer.
- B. Manufacturer's Qualifications
 - 1. ISO 9001 Certified manufacturing plant and processes.
 - 2. Only hood manufacturers who have had fume hoods as a principal product for 30 years are considered.
- C. Fume hoods superstructure shall be **Made in America**.
 - 1. 95% or more of raw material and component suppliers for fume hoods superstructure shall be United States based.

2. Stainless and cold rolled steel used in manufacturing shall be sourced from United States steel mills.
 3. Final product must be fabricated and assembled within the United States of America.
- D. Supply all equipment in accordance with this specification. Offering a product differing in materials, construction, or performance from this specification requires written approval obtained seven days or more before the proposal deadline.
- E. The owner/architect reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.
- F. Manufacturer’s warranty against defects in material or workmanship on its fume hoods will be for 1 year from date of installation or 2 years from date of purchase, whichever is sooner, and includes replacement of parts (except lamps) and labor.

1.06 SUBMITTALS

A. Action Submittals

1. Laboratory hood specification sheets and product manuals shall be submitted by the hood manufacturer upon request, and include safe and proper operation and maintenance information.
2. Shop Drawings: Include plans, elevations, sections, and details.
 - a. Indicate details for anchoring fume hoods to permanent building construction including locations of blocking and other supports.
 - b. Indicate locations and types of service fittings together with associated service supply connection required.
 - c. Include rough-in information for mechanical, plumbing, and electrical connections
3. Submit a document detailing the information supplied on the Hood Safety Practices Label to verify compliance to specifications.

B. Informational Submittals

1. Product Test Reports: Showing compliance with specified performance requirements, including NEBB representative test report and AFNOR report as defined previously.
2. Independent validation:
 - a. Written verification from an outside testing agency confirming coating compliance to SEFA 8-2010, Recommended Practices for Laboratory Grade Metal Casework, 8.0 Cabinet Surface Finish Tests.
3. Documentation of ISO 9001 Certified manufacturing plant and processes.
4. List of five installations (of equal or larger size and requirements) for filtration technology and hood super structure is available upon request. Provide contact at each.
5. Declaration of Made in America. Owner reserves the right to evaluate Made in America claims for compliance with the Bureau of Consumer Protection.

C. Material Submittals

1. Samples for Verification: of the hood exterior wall material, interior liner material, epoxy work surface material, and color selection chips are available from the hood manufacturer upon request.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of

polyethylene film or another suitable material.

- B. Schedule delivery of equipment so that spaces are sufficiently complete that equipment can be installed immediately following delivery.

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install fume hoods until building is enclosed, wet work and utility rough-ins are complete, and the HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Labconco Corporation, 8811 Prospect Avenue, Kansas City, Missouri 64132,
- B. Supplied By Preferred Dealer; Canadian Scientific Lab Systems Inc, 7777 Eastview Road, Guelph, Ontario Canada. Contact # 519-835-2949, Email: info@canadianscientific.ca
- C. Basis-of-Design Product: Labconco Protector® Echo™ 6-foot wide

2.02 MATERIALS

- A. Hood Interior Liner
 - 1. Liner material must comply with UL 1805, and be listed within NRTL test report as proof of compliance
 - 2. General Material Properties
 - a. Nonflammable, corrosion and chemical-resistant
 - b. Sheet molded homogenous polyester panels
 - c. Minimum thickness of 3/16"
 - d. Smooth, white finish
 - 3. Mechanical Properties
 - a. Tensile Strength: 7,500 PSI (51.7 Mpa)
 - b. Tensile Modulus: 1.7×10^6 PSI (11,700 Mpa)
 - c. Flexural Strength: 21,000 PSI (145 Mpa)
 - d. Flexural Strength at 130 degrees C: 12,900 PSI (89 Mpa)
 - e. Compressive Strength: 32,500 PSI (224 Mpa)
 - f. IZOD Impact Strength (Notched): 8.4 Ft-Lb/in (4.5 J/cm)
 - 4. Flame and Smoke Characteristics
 - a. Flame retardant, self –extinguishing, with a flame spread rating of 25 or less in accordance with ASTM-E84
 - b. Oxygen Index: 35%
 - c. Smoke Density: 115
 - 5. Physical Properties
 - a. Water Absorption: 0.4%

- b. Specific Gravity: 4.81
- c. Coefficient of Thermal Expansion: $2 \text{ in/in/degree C} \times 10^{-5}$
- d. Thermal Conductivity: $1.9 \text{ BTU/Hr/ft}^2\text{/in/degree F}$
6. Chemical Resistance
 - a. Splash and Spill resistance:
 - 1) Suspend sample panel in a vertical plane
 - 2) Apply five drops of each reagent listed with an eyedropper
 - 3) Apply liquid reagents at top of panel and allow to flow down full panel height
 - b. Fume Resistance:
 - 1) Place 25 milliliters of reagent into 100 milliliter beakers and position panel over beaker tops in the proper sequence. Ensure beaker pouring lip permits air to entire the interior atmosphere.
 - 2) After 24 hours remove panel, flush with water, clean with detergent, rinse, wipe dry and evaluate.
 - c. Evaluation ratings: change in surface finish and function shall be described by the following numerical ratings:
 - 1) No Effect: no change in color or gloss
 - 2) Excellent: slight detectable change in color or gloss, but no change to the function or life of the work surface material
 - 3) Good: clearly discernible change in color or gloss, but not significant impairment of function or life
 - 4) Fair: objectionable change in appearance due to surface discoloration or etch, possibly resulting in deterioration of function over an extended period of time
 - 5) Failure: pitting, cratering or erosion of work surface material; obvious and significant deterioration
 - d. Required minimum results for each reagent (Reagent: Fume Resistance Rating, Splash and Spill Resistance Rating)

1) Hydrochloric Acid (37%):	2,1
2) Sulfuric Acid (33%):	2,1
3) Sulfuric Acid (77%):	1,1
4) Sulfuric Acid (96%):	1,2
5) Formic Acid (90%):	2,1
6) Nitric Acid (20%):	2,2
7) Nitric Acid (30%):	1,2
8) Nitric Acid (70%):	3,2
9) Hydrofluoric Acid (48%):	2,2
10) Phosphoric Acid (85%):	1,1
11) Chromic Acid (60%):	1,4
12) Acetic Acid (98%):	1,1
13) Ammonium Hydroxide (20%):	1,1
14) Sodium Hydroxide (10%):	1,1
15) Sodium Hydroxide (20%):	1,3
16) Sodium Hydroxide (40%):	1,3
17) Sodium Hydroxide Flake:	1,-
18) Sodium Sulfide:	1,1
19) Zinc Chloride:	2,1
20) Tincture of Iodine:	3,3
21) Silver Nitrate:	2,1
22) Methyl Alcohol:	1,1
23) Ethyl Alcohol:	1,1
24) Butyl Alcohol:	1,1

25)	Benzene:	1,1
26)	Xylene:	1,1
27)	Toluene:	1,1
28)	Gasoline:	1,1
29)	Dichloro Acetic Acid:	2,2
30)	Dimethyl Formamide:	2,2
31)	Ethyl Acetate:	1,1
32)	Amyl Acetate:	1,1
33)	Acetone:	1,1
34)	Chloroform:	1,1
35)	Carbon Tetrachloride:	1,1
36)	Phenol:	2,2
37)	Cresol:	1,1
38)	Formaldehyde:	1,1
39)	Trichlorethylene:	1,1
40)	Ethyl Ether:	1,1
41)	Furfural:	1,3
42)	Methylene Chloride:	1,1
43)	Mono Chloro Benzene	1,1
44)	Dioxane:	1,1
45)	Methyl Ethyl Ketone:	1,1
46)	Acid Dichromate:	1,2
47)	Hydrogen Peroxide:	1,1
48)	Napthalene:	1,1

B. Sheet Steel

1. Side panels and access panels 20-gauge (or heavier) sheet steel.
2. Hood corner posts are 16-gauge sheet steel.
3. Cold-rolled, commercial steel (CS) sheet, complying with ASTM A 1008/A 1008M.

C. Chemical Resistant Finish

1. General: Prepare, treat and finish welded assemblies after welding. Prepare, treat and finish components that are to be assembled with mechanical fasteners before assembling.
2. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Third party validation required.
3. Powder-coat process required. Paint processes that release Volatile Organic Compounds (VOC) are not acceptable.
4. Color for Fume Hood Finish: **[Select One]**
 - a. Glacier White
 - b. As selected by architect from Manufacturer's full range

D. Safety Glass

1. Tempered
 - a. Clarity and temper test to be as specified in latest edition of Glass Tempering Association, *Engineering standards manual*, Section 8.1.
 - b. Surface and interior visible quality to be as specified per ASTM C 1036, *Standard Specification for Flat Glass*, Table 4, Quality level Q3.

2.03 CONSTRUCTION

A. Superstructure:

1. Self-supporting, rigid structural assembly, to support inner wall consisting of fume hood liner and outer wall of sheet metal exterior.
 2. Fabricated from galvanized steel.
 3. Space shall accommodate fume hood wiring and plumbing components for service fixtures.
 4. Access to fixture valves concealed in wall provided by exterior removable access panels, gasket access panels on the inside liner walls, or through removable access panels on the front posts.
- B. Exterior
1. Fabricate from steel sheet with component parts screwed together.
 2. Apply chemical-resistant finish to interior and exterior surfaces of component parts before assembly.
 3. Interchangeable side panels shall lift off without the use of tools to allow access to plumbing lines, service fittings, electrical wiring, counterbalance sash weights, and light fixtures. Exposed fasteners or hardware, and Velcro type fasteners are not acceptable.
 4. Corner posts
 - a. Pre-punched and plugged to accommodate up to 4 service fixtures per side
 - b. All services are accessible from the front of the hood.
 - c. Aerodynamic shape
 - d. Accommodate two electrical duplexes per side
 - e. Left hand corner post is pre-cut for optional airflow monitor installation
 - f. Unused penetrations shall be plugged
 5. Top and sides of face opening to provide an aerodynamic shape to ensure smooth, even flow of air into fume hood.
 6. Panel above header shall be removable without the use of tools to allow access to electrical wiring, counterbalance sash weights, light fixtures, filters, and fans. Exposed fasteners or hardware, and “hook-and-loop” type fasteners, are not acceptable.
- C. Dimensions
1. Overall exterior dimensions are as follows:
 - a. 6 foot nominal width: 72” w x 66” h x 37.7” d
 2. Overall interior dimensions are as follows:
 - a. 6 foot nominal width: 62.1” w x 48” h x 31.3” d
- D. Hood Liner
1. Adhere interior liner components to superstructure
 2. Stainless steel fasteners shall be used on the interior ceiling for structural integrity
 3. Fasteners exposed to chemical environment are not acceptable.
 4. Punch fume hood lining side panels to receive four service fittings, for use with remote controls, per side. Provide removable plug buttons for holes not used for indicated fittings.
 5. Each side wall shall include an oval interior access panel to provide access to the side wall of the fume hood for plumbing service access. Access panel material shall be that of the liner, and gasketed to form a vapor proof seal.
- E. Airfoil
1. Cold Rolled Steel with chemical-resistant finish.
 2. Airfoil shall have an aerodynamic radius to sweep the air into the hood with minimal turbulence. Airfoil directs airflow across work top to remove heavier-than-air gases.
 3. Must have 5 rows of perforations to allow the air to bypass underneath and through the foil and sweep across the work surface to prevent any back flow of fumes escaping from the front of the hood’s face. This airflow continues even if blocked by the presence of the

operator.

4. Foil must extend back under the sash to prevent closure of the lower by-pass opening when the sash is in the fully closed position, directly on top of the airfoil.

F. Sash Assembly

1. Glass: fully tempered safety glass with unobstructed, side-to-side view of fume hood interior and service fixture connections.
2. Dimensions: the full sash opening height is 28” for (un)loading; the total unobstructed viewing height is 37.5” measured from the work surface.
3. Sash tracks: steel with chemical resistant finish. Shall include bump stops for opening and closing.
4. Sash handle: extruded aluminum with chemical resistant finish. Sash handle includes a perforated air passage directly atop the handle to bleed air into the hood chamber and direct chemical fumes away from the user’s breathing zone. The handle is ergonomic in design and is easy to grasp when operating.
5. Sash guides: corrosion resistant extruded poly-vinyl chloride.
6. Sash System
 - a. Vertical sash (Cable and Pulley)
 - 1) Hoods have a single vertical sash counterbalanced by a single weight (excluding rear glass models)
 - 2) Glass models have 2 rear-side mounted weights
 - 3) Sash and weight to be connected via aircraft cable meeting MIL-W-83420 Military Specification.
 - 4) Front pulleys shall be connected via timing shaft to prevent sash tilting and permit one finger operation at any point along full width of sash handle. Maximum 7 pounds pull required to raise or lower sash throughout its full length of travel.
 - 5) Design system to hold sash at any position without creep and to prevent sash drop in the event of cable failure
 - 6) Include a defeatable, and automatically resetting sash stop positioned for a 16” sash height
 - 7) Includes sash stop locations for 60, 80, and 100 fpm sash height settings.

G. Electrical Components

1. Lighting
 - a. Provide UL Listed, lighting systems, to be mounted as part of column filter system
 - 1) 6 Foot Hoods – 4 LED light bars (one per module)
2. Electrical Receptacles
 - a. The hoods shall accommodate up to four (two per corner post) electrical receptacles as indicated in schedule or drawings. Receptacles to be 115 volt, 60 Hz, three-wire polarized and grounded electrical duplex, with Ground Fault Circuit Interruption (GFCI)]
 - b. Receptacles shall be individually wired to field wiring box, and each rated at 20 Amps.
 - c. Cover plates shall be acid resistant thermoplastic.
3. Wiring
 - a. Every electrical component shall be wired to an internal field wiring box (including individual duplexes/receptacles).
 - b. Field wiring box to be 7” x 4” x 2.5”, grounded, and have (12) 7/8” diameter knock out penetrations.
 - c. Final wiring and circuit dedications is to be by others. Wiring to be hardwired through conduit.

- d. Each receptacle circuit shall accommodate being wired to a dedicated building circuit rated at 10A, or the receptacles ganged together on a building circuit with the total load not to exceed 20 Amps. Wiring to be hardwired to hood.
 4. Fume hood to have third party validation of compliance to UL 61010-1 by a Nationally Recognized Testing Laboratory (NRTL).
- H. Hood Safety Practices Label: Corrosion resistant plate on the corner post of the fume hood with the following Hood Safety Practices:
1. For use with substances that produce hazardous levels of airborne chemicals; gas, fumes and vapors. HEPA filter required for: aerosols and dust.
 2. Do not put your head in the hood.
 3. Minimize drafts and sudden movements in front of the hood.
 4. Work a minimum of six inches inside the hood.
 5. Elevate equipment above the work surface.
 6. Keep sill and baffle unobstructed.
 7. Do not use the hood for storage.
 8. Adjust the sash to smallest opening possible when in use.
 9. Close sash when unattended.
 10. Do not remove any of the hood components
 11. Do not place flammable solvents near heat, flame or sparks.
 12. Do not evaporate large amounts of liquids.
 13. Wipe up spills immediately.
 14. Routinely validate airflow.
 15. If airflow alarm indicates unsafe condition, immediately close sash, discontinue hood operation and call for help.
- I. Hood Usage Label: Corrosion resistant plate with the following information:
1. Filtered Fume Hood Airflow Diagram
 2. Do not use with: Organophosphoric Compounds, Mercury, Hydrogen Cyanide, Radioisotopes, Perchloric Acid, and Highly exothermic reactions.
- J. Filtration Components
1. The filtration fume hood assembly shall require all necessary components and design features to be installed and perform as a completely autonomous exhaust and filtration system; entirely independent of and unaffected by the building mechanical systems.
 2. In the interest of protecting the health and welfare of the laboratory technicians, the manufacturer of filtered fume hood must demonstrate their design will safely and efficiently contain toxic vapors and fumes generated within the enclosure and effectively remove all said contaminants from the air prior to returning the air to the lab environment. To demonstrate compliance:
 - a. The fume hood manufacturer shall submit the test results for ASHRAE 110-2016 for face velocity, smoke challenges and containment efficiency.
 - b. The fume hood manufacturer shall provide results for AFNOR NFX 15-211 molecular filtration effectiveness testing for at least one acid, on base and one solvent.
 - c. These tests must be performed by an independent third party testing authority with a proven record of experience performing these two test protocols (as defined above).
 3. Additionally, the filtration manufacturer shall provide two chemical lists:
 - a. A comprehensive list of chemicals approved for use with the media. This list shall include hundreds of chemicals that represent the vast majority of chemicals used in wet chemistry and corresponding retention capacities. The test protocol shall be in accordance with AFNOR NFX 15-211.

- b. A list of chemicals and applications not recommended for use with the media.
4. The system fans shall effectively trap and contain the contaminated air within the fume hood enclosure then transport it, along with the contaminants, into and through the filtration media removing all chemicals from multiple families of acids and solvents using the same charcoal media for all families. The managed air flow rate shall serve to guarantee the necessary residence time for contaminants to remain within and be exposed to the media. The objectionable components in the airstream shall be adsorbed and clean filtered air returned to the space.
5. A universal type of carbon filtration media shall be employed for the purpose of adsorbing all chemical families. Multiple layers of task specific media are not acceptable.
6. Safety Features:
 - a. Include:
 - 1) Fume hood protocol for user interface shall be controlled by computer software with defined levels of access.
 - 2) The first level shall be defined as “User” or lab technician/hood operator. This card level access enables the operator to control the fan/blower and light operation on/off.
 - 3) The second level of access shall be defined as the “Administrator.” This definition will allow a designated individual, like a safety officer, who will be assigned responsibility for the hood network. By use of a password, the software shall give this individual access to recorded usage and alarm history.
 - 4) The hoods highest and unrestricted level shall be defined as the “Maintenance” level. By use of a password, it shall provide access to all of the above plus calibration and troubleshooting features.
 - b. All Alarms shall be in an audible and visual format. The alarm software shall be programmable to support remote monitoring and alerts.
 - c. Alarm signals, status and all ventilation operational parameters shall be available via Ethernet IP, WiFi and Bluetooth connectivity.
 - d. The hood shall be equipped with a filter saturation detection system capable of detecting solvents (optional acids and/or formaldehyde). The detection system shall have accuracy sufficient to guarantee no re-entrainment of contaminated air to the laboratory of greater than 1% of the published TLV adopted by the American Conference of Government Industrial Hygienists for each chemical.
 - e. Back up redundancy filtration shall be provided. A second layer of fully redundant filtration media shall be provided to assure continued capture of contaminants beyond the saturation level of the primary filters. Secondary filters of non-equal capacity are not acceptable.
 - f. A high temperature alarm system shall be included. Alarms shall trigger when the temperature reaches 104°F (60°C) and remains steady. A second alarm shall sound if the temperature reaches 140°F (60°C) and signal the hood’s fan/blower to shut off. Temperature sensor shall be included in each filtration column. Set points for temperature sensors are to be adjustable.
 - g. In order to preclude the possibility during filter rotation of reusing a loaded filter, an electronic filter I.D. system must be included; thus preventing the placement of a previously used and loaded filter into the primary or secondary filter position.
 - h. Airflow alarm is programmable and when sash is raised above the defeatable sash stop or when airflow face velocity falls below set point.
 - i. A high humidity alarm system shall be included. Alarm shall trigger at 80% RH (adjustable). Humidity sensor shall be included in each filtration column.
7. Manufacturer shall provide a minimum of (3) customer references that use a multitude of chemicals and have been installed for at least 36 months.

8. Manufacturer shall provide the client with a customer site visit that has a minimum of (24) months of operation with similar research or pedagogy.
 9. Prior to a sale, a risk assessment of each unique customer application shall be performed, including all chemicals to be used in each fume hood, the containers, temperature, quantity, frequency and duration of the use. This risk assessment shall be reviewed and approve or deny containment, filtration, detection and estimated filter life. Additionally, the risk assessment shall determine which options may be mandatory (acid sensor, formaldehyde sensor, HEPA filters, ammonia prefilters).
- K. Optional Fume Hood Accessories
1. Service Fixtures: Color-coded hose nozzle outlets and valves mounted inside the fume hood and controlled from the exterior with color-coded index handles
 - a. The hoods are equipped without service fixtures or will be provided with a total of up to 8 service fixtures as indicated in schedule.
 - b. Hose connectors located inside the fume hood cavity are chemically-resistant, glass-filled polypropylene with 6 serrations.
 - c. Service lines shall be factory installed from valve to outlet
 - 1) Copper tubing unless otherwise noted
 - 2) Brass service lines for gas
 - 3) Stainless steel service lines for deionized water
 - 4) Connections shall be made with quick-connect compression fittings on the inlet and outlet of the valve body, soldered and brazed connections not easily disassembled are not acceptable.
 - 5) Services to be pre-piped to the top of the hood.
 - d. Valves
 - 1) Extruded brass valve and rotating seat, TFE-coated silicone bronze stem and TFE packing.
 - 2) Fixture handles are plastic and color-coded as well as labeled for the designated type of service.
 - 3) Fixtures are rated at maximum pressure of 200 psi.
 - 4) Coefficient of flow for the valve, $C_v=0.43$.
 - 5) Valves are front loaded, located on the fume hood corner post for remote use, and include:
 - i. Hot and cold tap water (confirm location during shop drawing review, side to match cup sink)
 - ii. Vacuum
 - iii. Nitrogen (for future use)
- L. Work Surface
1. 1.25" thick, molded from solid modified epoxy resin, with smooth, non-specular, black finish.
 2. One inch radius front edge for optimal fume hood performance.
 3. 3/8" dished area to match the fume hood interior work space and form a water tight pan for spill containment.
 4. Include a 2.5" diameter hole on each side for service pass-through and piping. Hole to be covered by hood superstructure upon installation.
 5. Include two 1.5" diameter penetrations to accommodate base cabinet venting. Holes to be located outside of dished area and covered by solid plugs upon installation.
 6. Physical Properties:
 - a. Flexural Strength: Not less than 10,000 psi (70 MPa).
 - b. Modulus of Elasticity: Not less than 2,000,000 psi (1,400 MPa)

- c. Hardness (Rockwell M): Not less than 100
 - d. Water absorption (24 Hours): Not more than 0.02%
 - e. Heat Distortion Point: Not less than 260°F (127°C).
 - f. Flame-Spread Index: 25 or less per ASTM E 84.
7. Cupsink
- a. 3" x 6" dimension, polypropylene construction
 - b. Provide with strainers and tailpieces, NPS 1 ½ (DN 40)
 - c. To sit flush with dished area of work surface
 - d. Cupsink(s) to be located in rear right or left (confirm location during shop drawing review).
- M. Supporting Base Cabinets
1. Base cabinets shall be in depths of 22", widths, quantities, and types called out in the equipment drawings and meet the requirements of this specification.
 2. Construction requirements for all cabinets
 - a. Exterior construction is 18 gauge (or heavier) cold rolled sheet steel with Chemical Resistant Finish.
 - b. Hinges are 10 gauge (or heavier) plate with self-clinching pilot pin. Knuckle, bullet, or piano type hinges are not acceptable.
 - c. The rear panel will feature a 12" x 8" removable plumbing access panel.
 - d. Units 24" wide or less have only one door.
 - e. Each cabinet includes four leveling feet.
 - f. Capable of supporting up to 800 pounds.
 - g. A filler panel is required to increase the cabinet depth to work surface depth.
 3. Standard Storage
 - a. Overall exterior Dimensions:
 - 1) 18" 18" w x 22" d x 35.5" – 36.75" h or 31.5" – 32.75" for ADA cab
 - b. Pull handles are stainless steel.
 4. Acid Storage
 - a. Overall exterior Dimensions:
 - 1) 18" 18" w x 22" d x 35.5" – 36.75" h or 31.5" – 32.75" for ADA cab
 - b. Pull handles are stainless steel.
 - c. Completely lined with polyethylene corrosion resistant liner. The liner is 3/16" thick, with a vacuum formed PVC liner pan at the bottom to contain spills. Each door has a 3/16" sheet polyethylene liner.
 - d. The cabinet is labeled "ACID". And comes with label for "BASE"
 - e. Supply an epoxy coated steel shelf with PVC liner pan if indicated in the schedule.
 - f. Acid cabinets with louvers are not acceptable.
 - g. Cabinets to have rear outlets (one high and one low) for ventilation.
 5. Solvent Storage
 - a. Overall exterior Dimensions:
 - 1) 18" 18" w x 22" d x 35.5" – 36.75" h or 31.5" – 32.75" for ADA cab
 - b. Solvent storage cabinets are specifically designed for the storage of flammable and combustible liquids.
 - c. Solvent storage cabinets must be compliant with NFPA 30 "Flammability and Combustible Liquids Code."
 - d. Cabinets 30" wide and greater shall be tested and approved by Factory Mutual to meet Factory Mutual Approval Standard 6050.
 - e. The bottoms, top, sides, and doors are fabricated of 18 gauge steel and are all double panel construction with a 1 ½" air space between panels.
 - f. All joints are welded or screwed to provide a rigid enclosure. A 2" deep liquid tight pan that covers the entire bottom of the cabinet is furnished to contain liquid leaks and

- spills.
- g. A full-depth, 18 gauge steel, adjustable shelf will be provided. Shelves are sealed leak tight.
 - h. Two diametrically opposed flame arrestor vents with spark screens are provided in the back of the cabinet, as well as a grounding screw.
 - i. The cabinet has an interior finish the same as the exterior.
 - j. The cabinet is labeled: "FLAMMABLE – KEEP FIRE AWAY"
 - k. The right hand door shall have a three point latching device.
 - l. Door handles include key lock. Solvent storage handles are locking level handles with bright chrome finish.
 - m. If noted on the schedule, self-closing/self-latching models shall be provided with a fusible-link feature to ensure the doors will close if the temperature outside the cabinet exceeds 165°F The doors are synchronized so that both doors will fully close.

6. Vacuum Pump Cabinet and Vacuum Pump

- a. A single vacuum pump and cabinet may serve two fume hoods that are immediately adjacent.
- b. Cabinet
 - 1) Overall exterior dimensions:
 - i. 18" 18" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - 2) Completely lined with sound absorption foam including door.
 - 3) Supplied with a pull-out tray and removable access panel at back of cabinet.
 - 4) Supplied with an on/off switch (for remote control) and a 120V/15amp duplex receptacle on the rear of the cabinet outlet pre-wired to a junction box and 8ft of wiring.
 - 5) Supplied with vibration isolators for vacuum pump mounting.
 - 6) The cabinet is labeled: "VACUUM PUMP".
 - 7) Pull handles are stainless steel.
 - 8) Cabinet door to have louvers at low level for ventilation.

c. Vacuum Pump

- 1) General:
 - i. Dry scroll type vacuum pump with all bearings and their hydrocarbon lubricant isolate from the vacuum space. Pump suitable for vapor handling processes and some pumping applications involving corrosive substances.
 - ii. Designed for use with acids below 20% concentration and solvents including acetonitrile.
- 2) Controller:
 - i. Integral pump controller manages pump speed, monitors power and temperature, and will protect the pump in the event of operation under sustained high load or fault conditions.
 - ii. Controller to be capable of operating pump without any external signal except for an on/off signal. Controller to include LED lights for indication of power, run, standby, standby speed increase, standby speed decrease, auto-run, service required, and alarm.
- 3) Construction:
 - i. All surface of the pump exposed to the pumped gases are free from copper, zinc, and cadmium. Exposed components include anodized aluminum scrolls, aluminum housing, nickel-plated inlet and exhaust ports, PTFE composite tip-seals, various stainless-steel parts and fluorocarbon elastomer seals.

- ii. Body of pump includes a fixed scroll and an orbiting scroll. Orbiting scroll controlled by an electric motor through an eccentric cam on the motor drive shaft. The movement of the orbiting scroll meshed with the fixed scroll forms successive crescent shaped volumes in the pump. Gas entering the pump through the inlet is compressed by the movement of the orbiting scroll and swept towards the center of the fixed scroll. The compressed gas enters the exhaust port near the center of the fixed scroll and is exhausted from the pump through the outlet.
- iii. Optimal bearing placement for long-lifetime and easy replacement and unique tip seal designed to significantly reduces wear to minimize maintenance and extend service life.
- iv. High efficiency radial air-gap motor.
 - 4) Vacuum (ultimate, partial pressure): 2×10^{-2} mBar (15 micron)
 - 5) Noise: Quiet operation of <52 dB(A) for minimal environmental impact
 - 6) Inlet connection: 3/4" OD inlet adapter
 - 7) Overall dimensions: 20.0" w x 12.0" d x 15.0" h
 - 8) Shipping weight: 59 lbs. (27 kg)
 - 9) Power: 115V/1ph/60HZ, 10A, includes power cord and plug
 - 10) Accessories:
 - i. Pump silencer: Filters exhaust while silencing exhaust pump noise. Includes filter, centering ring and clamp to attach to exhaust outlet.
 - 11) Acceptable material: Labconco Scroll Vacuum Pump Model 7587100 / Edwards Vacuum nXDS scroll pump
- d. Vacuum pump piping
 - 1) Piping between vacuum pump and fume hood service connection to be PTFE tubing with PVDF compression fittings.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Examine areas, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.
- B. Coordinate with other trades for the proper and correct installation of plumbing and electrical rough-in and for rough opening dimensions required for the installation of fume hoods.
- C. Examine the carton and its contents for damage that might have occurred in transit.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install fume hoods according to shop drawings and manufacturer's written instructions.
- B. Install level, plumb and true; securely anchor as required.
- C. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

- D. Install according to standards required by authority having jurisdiction.
- E. Touch up minor damaged surfaces caused by installation. Replace damaged components as directed by Architect.

3.03 FIELD QUALITY CONTROL

- 1. NFPA 45 requires that fume hoods shall be field tested when installed.

3.04 ADJUSTING AND CLEANING

- A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Verify that counterbalances operate without interference.
- B. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- C. Clean adjacent construction and surfaces that may have been soiled or damaged in the course of installation of work in this section.
- D. Provide all necessary protective measures to prevent exposure of equipment and surfaces from exposure to other construction activity.
- E. Advise contractor of procedures and precautions for protection of material and installed equipment and casework from damage by work of other trades.

1. GENERAL

1.1 Summary

- .1 Provide manual and motorized roller windows shades in accordance with requirements of the Contract Document.
- .2 Indicated as RS-1M, RS-2M, RS-3M in Section 09 06 06.

1.2 Reference Standards

- .1 American Architectural Manufacturer's Association (AAMA):
 - .1 AAMA 611, Voluntary Specification for Architectural Anodized Aluminum
- .2 American National Standards Institute (ANSI)/Window Covering Manufacturers Association (WCMA):
 - .1 ANSI/ WCMA A100.1, Safety of Corded Window Covering Products
- .3 American Society for Testing and Materials (ASTM):
 - .1 ASTM B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
- .4 Underwriters Laboratories Canada (ULC):
 - .1 CAN/ULC S109 Flame Tests of Flame Resistant Fabrics and Films

1.3 Administrative Requirements

- .1 Scheduling: Schedule installation of roller shades only after wet and dirty finish work in spaces; including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.4 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
 - .1 Product Data: Submit information for each type of product indicated including, but not limited to, the following:
 - .1 Styles, material descriptions, construction details, dimensions of individual components and profiles, features, and finishes.
 - .2 Operating instructions.
- .2 Shop Drawings: Submit for Consultant's action:
 - .1 Submit shop drawings indicating location and extent of roller shades including, but not limited to, the following:
 - .1 Elevations, sections, details, and dimensions not shown in submitted product data.
 - .2 Installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.

- .3 Samples: Submit for Consultant's action. Submit two (2) samples prior to starting work of this section as follows; accepted samples will form the standard of acceptance for the remainder of the work:
 - .1 Verification Samples: Submit samples for verification of selected products as follows:
 - .1 Complete, full-size operating unit not less than 400 mm wide for each type of roller shade indicated.
 - .4 Schedules: Submit for Consultant's action: window treatment schedule using same room designations as indicated on Drawings.
- 1.5 Project Closeout Submissions
- .1 Provide operations and maintenance information including the following:
 - .1 Methods for maintaining roller shades and finishes.
 - .2 Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
 - .3 Operating hardware.
 - .2 Submit manufacturers standard maintenance contract for review by Owner.
- 1.6 Quality Assurance
- .1 Regulatory Requirements:
 - .1 Flame Spread Rating: Provide roller shade panel materials with flame spread and smoke developed characteristics required by Authority Having Jurisdiction, as determined by testing identical products in accordance with CAN/ULC S109.
 - .2 Qualifications:
 - .1 Installer: Use installer experienced and who has completed installations of roller shades similar in material, design, and extent to that indicated in this Section; submit proof of capabilities when requested by Consultant.
 - .2 Supplier: Obtain roller shades through one source from a single manufacturer, from a manufacturer approved supplier.
- 1.7 Delivery, Storage And Handling
- .1 Delivery and Acceptance Requirements: Deliver shades in factory packages, marked with manufacturer and product name, fire test response characteristics, and location of installation using same room designations indicated on Drawings and in a window treatment schedule.
- 1.8 Site Conditions
- .1 Site Measurements: Verify dimensions of adjacent construction by site measurements before fabrication and indicate measurements on shop drawings where roller shades are indicated to fit to other construction:
 - .1 Allow clearances for operable glazed units' operation hardware throughout the entire operating range.
 - .2 Notify Consultant of discrepancies.
 - .3 Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.9 Warranty

- .1 Manufacturer Warranty: Provide manufacturer's warranty from commencing from date of Substantial Performance covering the following minimum requirements for materials:
 - .1 Shade Hardware including Electric Motors and Controllers: ten (10) years.
 - .2 Electronic Control Equipment: five (5) years
 - .3 Shade Fabric/Shade Cloth: ten (10) years.
 - .4 Metal Coatings: ten (10) years.

2. PRODUCTS

2.1 Basis-of-Design Materials

- .1 Basis-of-Design: Legrand SPEC SERIES FASCIA SHADE SYSTEM SS-XXXX.

2.2 Shade Summary

- .1 Refer to Section 09 06 06; eight feet and above are motorized, manual shades below 7'11" (chainless). Locations as indicated on Drawings.
- .2 Refer to Section 09 06 06 - Schedule of Finishes for details of fabric type and openness.
 - .1 RS – #: Roller Shade – Not Motorized (Manual)
 - .2 RS – # M: Motorized Roller Shade
- .3 All shades to be motorized.
- .4 Housing to be installed as indicated on drawings.
- .5 Fascia color to coordinate with mullion color.
- .6 Standard Single Shade and Dual Shade to be provided as follows:
 - .1 All Offices to have Standard Single Shade – RS-1M
 - .2 All Classrooms/Multipurpose Rooms, Meeting Room, Knowledge Sharing Space and Ceremony Room to have Dual Shade – RS-3M
 - .3 Lounge/Event Space to have Standard Single Shade – RS-1M
 - .4 Width of Shades to fill entire window cavity unless noted otherwise on elevations.

2.3 Roller Shade Components

- .1 Roller Tube: One piece extruded 6061-T6 or 6063-T6 aluminum roller tube meeting the requirements of ASTM B429, having anodized finish as follows:
 - .1 Protective Finish: AA-M12 Mechanical Finish; C22 Non-Specular; A21 Chemical Finish, etched, medium matte anodic coating; clear coating 0.025 mm or thicker in accordance using AMA 611; roller tube assemblies having mill finish will not be acceptable.
 - .2 Tube Diameter and Thickness: Manufacturers recommended engineered diameter, wall thickness and aluminum grade as required for maximum allowable deflection of L/700
 - .3 Tube Configuration: Extrude tube with provision made for mechanical engagement with the operator and drive assembly; and having channels to accept fabric attachment spline.
- .2 Fabric Spline: Extruded vinyl profile, welded to fabric band or panel, allowing removal and re-installation of fabric bands or panels without removing the roller tube and hardware and having the following characteristics:
 - .1 Fabric bands or panels must be replaceable on site.

- .2 Attachment of the fabric to the tube with double-sided adhesive tapes, adhesives, staples or rivets will not be acceptable.
 - .3 Hem Bars and Hem Bar Pockets:
 - .1 Round shaped aluminum profile; nominal 15 mm diameter with wall thickness engineered to suit weight requirements; slide hem bar into welded fabric hem bar pocket with open ends; finished ends of hem bar with coloured PVC round end caps colour to match fabric.
 - .4 Fasteners: Non-corrosive fasteners as recommended by manufacturer.
 - .5 Valance: As indicated by manufacturer's designation for style and colour.
 - .6 Mounting: as indicated on Drawings, mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.
 - .7 Motorized Shade Description:
 - .1 The Legrand Shading Systems Spec Series Fascia roll roller shade bracket system has options for motor operated shades, manually operated shades (no chain), and convertible manual to motorized (MTM) operated shades.
 - .2 The fascia brackets come in three sizes and can support shades up to 13 feet wide by 15 feet tall with up to 6 shade bands per motor.
 - .3 The Spec Series has several fascia options to fit any bracket including front and back fascia.
 - .4 The fascia is easy to install using a simple clip on system. Accessories such side channels and sill rails are available for room darkening applications and mates with the fascia to maximize darkening. In addition, there are bracket options for dual shades, shades in pockets, and bottom loading shades.
 - .5 There are color coordinated bracket covers provided with each shade that match the bracket and fascia color options and finish the installation.
 - .6 The DLM/QIS shade motors have a unique counter-balance spring design that allows shade to use less energy and for extremely quiet operation.
 - .7 This patented design also allows the shades to be manually pulled into position using the hembar. This feature is unique to the Legrand system.
 - .8 OPERATION
 - .1 The SS bracket system offers universal mount brackets that can be mounted inside or outside the window and top, back, or side mounted. There are several bracket series that allows for the proper selection of shades for different applications.
 - .2 The motorized only brackets allow for a number of fascia or pocket installed roller shade sizes and application.
 - .3 The manual-to-motorized bracket (MTM) system allows for standalone manual chain operated shades or a manual chain operated shade to be converted to a motorized shade simply by removing the clutch and chain system and adding a motor and controls.
 - .4 The manual Chain-free system requires a slight tug to the hembar to raise the shade.
 - .5 All Legrand motorized shades are available as a standalone system or as part of a fully automated system using any Legrand lighting control solution.
 - .6 The added benefits of combining the lighting controls with shading allows for shading and lighting control to operate in parallel to increase energy efficiency and occupant comfort. When combined with Wattstopper Lighting control systems the DS motorized shades offer true shade and lighting automation using astronomic timers, photocells sensors, and other sensors.
- 2.4 Shade Material
- .1 Shading Material: Must be Commercial grade fabric; residential grade fabric is not acceptable.

- .2 Rollers: Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade panel material without sagging; designed to be easily removable from support brackets; with hook-and-loop strip or manufacturer's standard method for attaching shade material.
- .3 Direction of Roll: Regular, from back of roller, for double roller application.
- .4 Mounting Brackets: Galvanized or zinc-plated steel.
- .5 Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated on Drawings; removable design for access.
- .6 Top/Back Cover: L shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.
- .7 Bottom Bar: Steel or extruded aluminum, with plastic or metal capped ends. Provide exposed-to-view, external-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

2.5 Operator

- .1 Motorized Operator:
 - .1 Mounting Brackets: Angle shaped brackets size and thickness to manufacturer's standard; unitized pre-moulded assembly in lengths to suit system supplied; attached to high density polyethylene brackets, using manufacturer's standard adjustable motor coupling and end support assemblies.
 - .2 Motor Drive System: Manufacturer's standard in-tube motor drive having the following characteristics:
 - .1 Coupled shade panels being driven by a single motor may be coupled at a maximum angle of up to 90°.
 - .2 Mounting assembly: Allow for continuous front or back roll fascia across multiple shades without exposed fasteners.
 - .3 Shade roller tube: Removable from mounting bracket without hardware removal; non-metal components shall be self-lubricating.
 - .4 Shade hardware system: Allow for site adjustments or component replacement without removing brackets, regardless of mounting location.
 - .5 Shade hardware: Allow for bottom-up or sideways roller tube installation and removal without removing brackets.
 - .6 Motor Characteristics: Asynchronous motor unit, start and run, 120 Volt - single phase - 1.5 Amp, thermally protected, brushless motor, permanently lubricated bearings and gearbox, containing all components for a properly functioning unit, and as follows:
 - Gears manufactured from non-corrosive metal containing a 3 phase planetary gear reducer; non-metallic planetary gearboxes will not be acceptable.
 - Shade motor located inside the extruded aluminum roller tube using appropriate adapters to allow for a smooth operation.
 - Lifting Capacity: 30% safety factor.
 - Sound Generated: not exceeding 30DB.
 - Equip shade motor using disconnect plug at motor lead.
 - Shade motor shall contain a conical steel disk brake allowing no slippage and adjusting to high torque.
 - Fit shade motor with solid steel adjustable drive extensions, rectangular bar shaped for drive and torque transfer to single or multiple coupled extruded roller tubes, to suit installation.

- Motor Speed: Adjustable from 12 to 30 RPM to suit Owners requirements and correct operation.
- Motor Lead: Plenum rated quality.
- Equip shade motor with externally located control wheels that allow exact control of shade position at the upper and lower shade location, preventing over winding of the fabric shade cloth.

2.6 Controls

.1 Basic Control Functions:

.1 Manual Switch Control: Shade manufacturer's standard control system including the following characteristics:

- .1 Single roller shade controlled by one switch. Switch: Rocker type momentary contact switch, recessed mounted, rated for 120V AC 15 Amp with cover plate selected by Consultant from manufacturer's standard range.

2.7 Roller Shade Fabrication

.1 Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

.2 Concealed Components: Noncorrodible or corrosion-resistant-coated materials.

.1 Lifting Mechanism: With permanently lubricated moving parts.

.3 Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 23° C:

.1 Shade Units Installed at back of curtain wall back section as detailed (outside of jambs).

.4 Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting fascia, roller, and operating hardware and for hardware position and shade mounting method indicated.

.5 Installation Fasteners: Not fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

.6 Colour-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

.7 Colours of Metal and Plastic Components Exposed to View: As indicated by manufacturer's designations, unless otherwise indicated.

.8 Hembars and Hembar Pockets:

.1 Round shaped profile, 15 mm diameter, wall thickness engineered to weight requirements, in welded hembar pocket with open ends. Finished with coloured PVC round end caps.

.9 Fasteners: Non-corrosive as recommended by manufacturer.

2.8 Aluminum Finishes:

.1 All exposed aluminum shall be anodized oxide finish according to AA-M12C22A31 or coloured to match window framing.

- .2 Unexposed aluminum unless otherwise specified: mill finish.

2.9 Motorized Roller Shade Operators

- .1 General: Provide factory-assembled motorized shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by shade manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.
- .2 Comply with NFPA 70.
- .3 Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
- .4 Electric Motors: UL-approved or -recognized, asynchronous, totally enclosed, insulated, capacitor-start motors, complying with NEMA MG 1, with thermal overload protection, brake, permanently lubricated bearings, and limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.
 - .1 Service Factor: According to NEMA MG 1, unless otherwise indicated.
 - .2 Motor Characteristics: Single phase, 24V, 60 Hz.
 - .3 Motor Mounting: Within manufacturer's standard roller enclosure.
- .5 Position of Motor and Electrical Connection: Left side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated on Drawings.
- .6 Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop shade at fully raised and fully lowered positions.
- .7 Operating Features: Include the following:
 - .1 Group switching with integrated switch control; single face plate for multiple switch cut-outs.
 - .2 Capable of accepting input from building automation control system.
 - .3 Override switch.
 - .4 Back-up gear and crank operator for manual operation during power failures with detachable handle, manufacturer's standard length.

3. EXECUTION

3.1 Examination

- .1 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Roller Shade Installation

- .1 Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade panel is not closer than 50 mm to interior face of glass. Allow clearances for window operation hardware.

- 3.3 Adjusting
- .1 Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
- 3.4 Cleaning And Protection
- .1 Clean roller shade surfaces after installation, according to manufacturer's written instructions.
- .2 Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- .3 Replace damaged roller shades that cannot be repaired, in a manner approved by Consultant, before time of Substantial Completion.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Provide metal laboratory casework in accordance with requirements of Contract Documents.
- .2 Section Includes:
 - .1 Canadian Scientific - Air Master Systems steel metal casework design, furnishing and installing all casework and work tops. Furnishing and installing all filler panels, knee space panels and scribes as shown on drawings.
 - .2 Accessories: Furnish and deliver all service outlets, accessory fittings, electrical receptacles and switches, as listed in these specifications, equipment schedules or as shown on drawings
- .3 Removal of all debris, dirt and rubbish accumulated as a result of the installation of the metal casework to an on-site container provided by others, leaving the premises clean and orderly.

1.2 Reference Standards

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - .2 ASTM A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .3 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .4 ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-12.5, Mirrors, Silvered
- .3 Canadian Standards Association (CSA):
 - .1 CSA B651, Accessible Design for the Built Environment
- .4 International Code Council (ICC)
 - .1 ICC A117.1, Standard for Accessible and Usable Buildings and Facilities

1.3 Submittals

- .1 Supply all equipment in accordance with this specification. The offering of a product differing in materials and construction from this specification requires written approval. This approval must be obtained seven (7) days before the proposal deadline.
- .2 General Contractors should secure a list of approved casework manufacturers from the architect as a protection against non-conformance to these specifications.
- .3 The owner/architect reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.
- .4 Shop Drawings: For metal laboratory casework. Include plans, elevations, sections, details, and attachments to other work.

- .1 Indicate locations of blocking and other supports required for install casework.
- .2 Indicate locations and types of service fittings, together with associated service supply connection required.
- .3 Include details of utility spaces showing supports for conduits and piping.
- .4 Show adjacent walls, doors, windows, other building components, and other laboratory equipment. Indicate clearances from above items.
- .5 Include coordinated dimensions for laboratory equipment specified in other Sections.

1.4 Quality Assurance

- .1 Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated without delaying the Work, as documented according to ASTM # 548.
- .2 Source Limitations: Obtain laboratory casework, including tops, sinks, service fittings, and accessories, through one source from a single manufacturer.
 - .1 Obtain through same source from the same manufacturer as fume hoods specified in Division 11 Section "Laboratory Fume Hoods"
- .3 Product Designations: Drawings indicate sizes and configurations of casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes, similar door and drawer configurations, and complying with the Specifications may be considered.
- .4 Product Standard: Comply with SEFA 8M, "Laboratory Furniture-Casework, Shelving and Tables-Recommended Practices"
- .5 Flammable Liquid Storage: Where cabinets are indicated for solvent of flammable liquid storage, provide units that are listed and labeled as complying with the requirements of NFPA 30 for design, construction, and capacity of storage cabinets by UL, FM, or another testing and inspection agency acceptable to authorities having jurisdiction.
- .6 Manufacturers shall have a **minimum of (10) years'** experience manufacturing projects of similar size and complexity.
- .7 Must have a **minimum manufacture warranty of (5) years.**

1.5 Deliver, Storage And Handling

- .1 Do not deliver laboratory casework until painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas. If casework must be stored in other than installation areas, store only in areas whose environmental conditions meet requirements specified in "Project Conditions" Article below.
- .2 Protect finished surfaces from soiling and damage during handling and installation. Keep covered with polyethylene film or other protective covering.

1.6 Project Conditions

- .1 Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, wet-work is completed, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels through remainder of construction period.

1.7 Coordination

- .1 Coordinate layout and installation of metal framing and reinforcement in gypsum board assemblies for support of metal laboratory casework.

2. PRODUCTS

2.1 Manufacturers

- .1 Basis-of-Design: Air Master Systems Corp, distributed by Canadian Scientific.
- .2 Acceptable alternates will be reviewed

2.2 Materials

- .1 Metal: Commercial-quality, cold-rolled, carbon-steel sheet, complying with ASTM A 366; matte finish for sheet steel and ASTM A1008/1008M for cold rolled steel; suitable for exposed applications; and stretcher leveled or roller leveled to stretcher-leveled flatness.
- .2 Minimum Metal Thickness: Provide metal laboratory furniture components of the following minimum thicknesses:
 - .1 Sides, ends, fixed backs, bottoms, tops, soffits, and items not otherwise indicated: 0.0478 inch (18 gauge). Except for flammable liquid storage cabinets, bottoms may be 0.0359 inch (20 gauge) if reinforced.
 - .2 Back side panels, doors, drawer fronts and bodies, and shelves: 0.0359 inch (20 gauge). For back panels and doors for flammable storage cabinets, use 0.0478 (18 gauge) inch thick metal. For shelves more than 36 inches long, use 0.0478 (18 gauge) inch thick metal or provide suitable reinforcement.
 - .3 Intermediate horizontal rails, table aprons and cross rails, center posts, and top gussets: 0.0598 inch (16 gauge).
 - .4 Drawer runners, sink supports, and hinge reinforcements: 0.0747 inch (14 gauge).
 - .5 Leveling and corner gussets: 0.1046 inch (12 gauge).
- .3 Acid Storage-Cabinet Lining: 3/8" thick polypropylene insert or Plascoat paint finish.

2.3 Fabrication

- .1 General: Complete assembly and finish work at point of manufacture. Perform assembly on precision jigs to provide units which are square; fully reinforced with angles, gussets, and channels; and integrally framed and welded to form a dirt and vermin-retardant enclosure. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch.
- .2 Fabricate units on precision dies for interchangeability of like-size drawers, doors, and similar parts.
- .3 Flush Doors: Outer and inner pans formed and telescoped into box formation, with channel reinforcement full height on center of each pan. Fill doors solid with noncombustible, sound-deadening material.
- .4 Hinged Doors: Reinforce with formed angles on inner pans made with 1 piece of steel.
- .5 Drawers: Assemble fronts from telescoping outer pans, designed to eliminate raw edge of steel at top. Fabricate sides, back, and bottom of one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Provide drawers with rubber bumpers, runners, and positive stops to prevent metal-to-metal contact or accidental removal.
- .6 Adjustable Shelves: Front, back, and ends formed down with returned lip at front and back.
- .7 Toe Space: Provide metal toe space, fully enclosed, 4 inches high by 3 inches deep, with no open gaps or pockets.

- .8 Table Legs: Not less than 2 inch square, electrically welded tubing. Provide leg stretchers where necessary to comply with structural performance requirements. Weld or bolt leg stretchers to legs and cross-stretchers. Securely bolt legs to table aprons. Provide leveling device welded to bottom of each leg.
- .9 Leg Shoes: Vinyl or rubber, black, open-bottom type.
- .10 Utilities: Provide space, cutouts, and holes for pipes, conduits, and fitting in cabinet bodies to accommodate utility services and their support-strut assemblies.
- .11 Utility-Space Framing: Manufacturer's standard steel framing units consisting of 2 cold-rolled C-channel uprights, not less than 1-5/8 inches square by 0.10 inch thick, connected together at the top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch flat bars. Framing units may be made by welding C-channel material specified for uprights into rectangular frames instead of using U-shaped brackets.
- .12 Base Molding: Extruded vinyl or rubber, black, 4 inches high. Provide on fronts and exposed ends and backs of floor-mounted casework.
- .13 Filler Strips: Provide as needed to close space between cabinets and walls, ceilings, and indicated equipment. Fabricate from the same material and with the same finish as cabinets. Hem exposed edges.

2.4 Finish For Metal Laboratory Casework

- .1 All Steel Laboratory Products shall utilize a dry powder coat paint process by means of electrostatically spray, providing high-transfer efficiency low waste generation. Liquid-applied coatings shall not be acceptable. Manufacturer shall supply documentation that waste generated during the painting process, is a solid, non-hazardous material.
 - .1 Pretreatment: Finish process shall incorporate a phosphate conversion coating during the pretreatment/cleaning operation. Electrostatic application of dry powder shall follow. Coated parts shall pass through curing ovens, which shall cause the powder to melt, flow, gel, cure and bond onto the phosphatized steel substrate.
 - .2 Chemical Resistant Finish: Only highly chemically resistant, dry powder coated finishes that passes the SEFA 8 casework specifications for chemical and durability resistance, will be acceptable.
 - .3 Overspray Powder Paint: Shall be captured and re-sprayed. Efficiency shall be 99% effective in coating usage, reducing waste generation. A closed collection system shall be utilized for overspray that is not reused. Powder overspray, which cannot escape the facility, is collected in bulk, eliminating the need for daily replacement/disposal of filter media.
 - .4 VOC Emissions: Powder paint shall be sprayed and baked with a near zero (.29 lbs per gallon maximum) VOC (Volatile Organic Compounds) emissions.
 - .5 Off-gassing: After all steel powder coated parts have cooled from the curing ovens, the coating shall be firm and stable. No further emissions of "Off-gassing/Decomposition" vapors shall occur at room temperature.
- .2 Chemical-Resistant Powder Coat Enamel Finish: Immediately after cleaning and pre-treating, apply manufacturer's standard 2-coat, chemical-resistant, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of 1 mil for topcoat and 2 mils for system.
- .3 Chemical and Physical Resistance of Finish System: Provide metal laboratory casework with finish system complying with the following requirements for chemical and physical resistance:
 - .1 Chemical and Physical Resistance: capable of withstanding application of not less than 5 drops (0.25 ml) of the following reagents applied to finish surface; covered with a watch glass for 60 minutes, rinsed, and dried; with no permanent change in gloss, color, film hardness, adhesion, or film protection.

- .1 Acetic acid (98 percent).
 - .2 Hydrochloric acid (37 percent).
 - .3 Nitric acid (25 percent).
 - .4 Phosphoric acid (75 percent).
 - .5 Sulfuric acid (85 percent).
 - .6 Acetone.
 - .7 Benzene.
 - .8 Carbon tetrachloride.
 - .9 Ethyl acetate.
 - .10 Ethyl alcohol.
 - .11 Formaldehyde (37 percent).
 - .12 Furfural.
 - .13 Methyl ethyl ketone.
 - .14 Phenol (85 percent).
 - .15 Toluene.
 - .16 Xylene.
 - .17 Ammonium hydroxide (28 percent).
 - .18 Potassium hydroxide (25 percent).
 - .19 Potassium hydroxide (40 percent).
 - .20 Sodium carbonate (saturated).
 - .21 Sodium chloride (saturated).
 - .22 Sodium hydroxide (25 percent).
 - .23 Sodium sulfide (saturated).
 - .24 Zinc chloride (saturated).
 - .2 Moisture Resistance: No visible effect when exposed to the following:
 - .1 Hot water at a temperature of 190 to 205 deg F, trickled down the surface at a 45-degree angle for 5 minutes.
 - .2 Constant moisture using a 2-by-3-by-1-inch cellulose sponge, soaked with water, in contact with surface for 100 hours.
 - .4 Cold Crack: No effect when subjected to 10 cycles of temperature change from 20 deg F for 60 minutes to 125 deg F for 60 minutes.
 - .5 Adhesion and Flexibility: No peeling or cracking or exposure of metal when metal is bent 180 degrees over a ½ inch diameter mandrel.
 - .6 Colors: Comply with the following requirements for colors of metal laboratory casework finish:
 - .1 Color: Petal White.
- 2.5 Casework Hardware
- .1 Hardware, General: Provide manufacturer's standard satin-finish, commercial quality, heavy-duty complying with requirements indicated for each type.
 - .2 Hinges: Stainless-steel, 5-knuckle hinges complying with BHMA 156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 for doors less than 48 inches high and 3 for doors more than 48 inches high.
 - .3 Pulls: stainless-steel, fastened from back with 2 screws. Provide 2 pulls for drawers more than 24 inches wide.
 - .4 Door Catches: Nylon-roller spring catch or dual, self-aligning, permanent magnet catch. Provide 2 catches on doors more than 48 inches high.
 - .5 Drawer Guides: Steel Full Extension Ball Bearing Drawer Slide with Bright Zinc Finish, and complying with ANSI/BIFMA X5.5-2008, ANSI/KCMA A 161.1-2006, ANSI-BHMA A 156.9-2010, NSF/ANSI 2 Food Equipment, SEFA-8-2007, WI.

- .6 Label Holders: Stainless-steel or chrome-plated, sized to receive standard label cards approximately 1 by 2 inches, attached with screws or rivets.
- .7 Provide on all drawers.
- .8 Drawer and Cupboard Locks: Half-mortise or cylindrical type, 5-pin tumbler and dead bolt or cam, only cylinder exposed, brass with chrome-plated finish, complying with BHMA A156.11, Grade 1.
 - .1 Provide minimum of 2 keys per lock and 6 master keys.
 - .2 Provide on all drawers and doors.
- .9 Castors: For mobile casework, castors are replacing the toe kick height. Castors are 250# load capacity with 3" wheels, 4.25" load height and swivel radius of 2.75". Tread width 1.25". Must have tread brake and dust caps. Mobile cabinets must have an anti-tipping device.

2.6 Tops, Sinks And Troughs

- .1 Tops, General: Provide smooth, clean exposed tops and edges in uniform plane free of defects. Make exposed edges and corners uniformly beveled. Provide front and end overhang of 1 inch over base cabinets, formed with continuous drip groove on underside ½ inch from edge.
- .2 Sinks, General: Provide sizes indicated or manufacturer's closest standard size of equal or greater volume, as approved by Architect.
 - .1 Outlets: 1-1/2-inch NPS outlets with strainers and tailpieces a minimum of 6 inches long, of the same material as sink, or as otherwise approved by CM.
 - .2 Overflows: For each sink, except cup sinks, provide overflow of standard beehive or open-top design and with separate strainer. Height 2 inches less than sink depth. Provide in the same material as sink.
- .3 Epoxy Tops, Sinks and Troughs: Factory molded of modified epoxy-resin formulation, uniform mixture throughout full-thickness with smooth, non-specular finish.
 - .1 Physical Properties: Comply with the following minimum requirements:
 - .1 Flexural strength: 15,000 psi.
 - .2 Compressive strength: 30,000 psi.
 - .3 Hardness (Rockwell M): 100
 - .4 Water absorption (24 hours): 0.02 percent (maximum).
 - .5 Heat distortion point: 350 deg. F
 - .6 Thermal-shock resistance: Highly resistant.
 - .2 Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, test procedure 3.9.5:
 - .1 Acetone: Moderate effect.
 - .2 Acetic acid (98 percent): No effect.
 - .3 Hydrochloric acid (37 percent): No effect.
 - .4 Nitric acid (70 percent): No effect.
 - .5 Phosphoric acid (85 percent): No effect.
 - .6 Sulfuric acid (33 percent): No effect.
 - .7 Benzene: No effect.
 - .8 Butyl alcohol: No effect.
 - .9 Carbon tetrachloride: No effect.
 - .10 Ethyl acetate: No effect.
 - .11 Ethyl ether: No effect.
 - .12 Formaldehyde: No effect.
 - .13 Phenol (85 percent): No effect.
 - .14 Xylene: No effect.
 - .15 Ammonium hydroxide (28 percent): No effect.
 - .16 Sodium hydroxide (50 percent): Moderate effect.
 - .17 Zinc chloride: No effect.

- .3 Colors: Provide products that result in colors complying with the following requirements:
- .4 Color: Gray.
- .1 Top Fabrication Fabricate with factory cutouts for sinks and with plain butt-type joints assembled with epoxy adhesive and pre-fitted, concealed metal splines.
 - .1 Top Configuration: Square edge with drip groove and integral covered backsplash.
 - .2 Top thick: 1-1/4-inches.
- .2 Sink Fabrication: Molded in one piece with surfaces smooth, corners coved and bottom sloped to outlet; ½-inch minimum thickness.
 - .1 Provide sinks with ¼-inch-thick lip around perimeter of sink for drop-in installation.
 - .2 Bond epoxy sinks installed in epoxy tops to tops and finish to produce an integral unit with invisible joint line.
- .5 Cup Sinks: Epoxy, 3-by-6-inch nominal size.
- .6 Cup Sinks: Epoxy, polypropylene, glass, or stainless-steel as indicated on Drawings.
- .7 Troughs: Epoxy or stainless-steel, as indicated. Comply with requirements for materials and construction as specified for tops or sinks. Pitch to drain not less than 1/8 inch/foot.
- 2.7 Solvent Storage Cabinets
 - .1 Top, bottom and sides: 18 gauge steel, double wall construction with 1-1/2" air space, removable access and back panels; all joints welded. Set bottom of door two inches above bottom of cabinet to create a two inch deep well to contain spillage of liquids.
 - .1 Provide non-venting cabinets.
 - .2 Hardware:
 - .1 3 point latching device and lock.
 - .2 Full length piano hinge.
 - .3 Door operation: Manual.
 - .3 Cabinet grounding attachment: Screw at base of cabinet for firm attachment of grounding wire.
 - .1 Warning signs: Label cabinet: "FLAMMABLE – KEEP FIRE AWAY".
- 2.8 Corrosive Storage Cabinets
 - .1 Corrosive cabinet is a cabinet within a cabinet design. The inner cabinet shall be manufactured as a polypropylene fully welded insert or AMS Polyethylene based Plascoat finish. The inner and outside of the inner cabinet must be 100% covered with paint.
 - .2 Shall come with 1 adjustable shelf that is capable of 2" increment adjustments throughout the cabinet. Shelf clips must be manufactured the same material as the liner.
 - .3 Cabinet shall have a removable access panel in the back to have access to services.
 - .4 Must come with a ¼" thick poly tray at the bottom to help retain spills.
 - .5 Cabinet to come with a vent kit to vent into the fume hood.

2.9 Accessories

- .1 Pegboards: Polypropylene, epoxy, phenolic-composite, stainless-steel pegboards with polypropylene pegs and stainless-steel drip troughs.

2.10 Performance Requirements

- .1 Structural Performance: Provide metal laboratory casework capable of withstanding the following loads without permanent deformation, excessive deflection, or binding of drawers and doors.
 - .1 Shelves of Base, Wall, and Storage Cabinets: 200 lbs.
 - .2 Drawers: 150 lbs.
 - .3 Wall Cabinets: 150lbs/ft.
 - .4 Floor-Supported Base Cabinets: 100 lbs./ft/ within cabinets, 75-lbs/ft. countertop.

3. EXECUTION

3.1 Casework Installation - Other

- .1 Install plumb, level, and true; shim as required, using concealed shims. Where laboratory case work abuts other finished work, apply filler strips and scribes for accurate fit, with fasteners concealed where practical.
- .2 Utility-Space Framing: Secure to floor with 2 fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.
- .3 Base Cabinets: Set cabinets straight, plumb, and level. Adjust sub tops within 1/16 inch of a single plane. Fasten cabinets to utility-space framing, partition framing, wood blocking or reinforcements in partitions with fasteners spaced 24 inches on center. Bolt adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Where base cabinets are not installed adjacent to walls, fasten to floor at toe space with fasteners spaced 24 inches o.c. Secure sides of cabinets to floor, where they do not adjoin other cabinets, with not less than 2 fasteners.
- .4 Wall Cabinets: Hang cabinets straight, plumb, and level. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches on center. Align similar adjoining doors to a tolerance of 1/16 inch.
- .5 Install hardware uniformly and precisely. Set hinges snug and flat in mortises, unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
- .6 Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.2 Installation Of Tops

- .1 Field Jointing: Where possible, make in the same manner as shop jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project site processing of top and edge surfaces is not required. Locate field joints where shown on approved Shop Drawings.
- .2 Abut top and edge surfaces in one true plane, with internal supports placed to prevent deflection. Provided flush hairline joints in tops using clamping devices.
- .3 Where necessary to penetrate tops with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal to top in chemical resistance, hardness, and appearance.

- .4 Provide required holes and cutouts for service fittings.
- .5 Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- .6 Provide scribe moldings for closures at junctures of top, curb, and splash as recommended by manufacturer for materials involved. Match materials and finish to adjacent casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

3.3 Installation Of Sinks

- .1 **Underside Installation:** Use manufacturer's recommended adjustable support system for table-and cabinet-type installations.
- .2 Set top edge of sink unit in sink and top manufacturers' recommended chemical-resistant sealing compound and firmly secure to produce a tight and fully leak proof joint. Adjust sink and securely support to prevent movement.
- .3 **Semi-flush installation:** Use stainless-steel sink frame, complete with clamping lugs and pads. Before setting, apply a full coat of sink and top manufacturers; recommended sealant under rim lip and along top. Omit sink frame if sink is fabricated with an integral rim seal.
- .4 **Drop-in Installation:** Rout groove in top to receive sink rim if not prepared in shop. Set sink in adhesive and fill remained of groove with sealant or adhesive. Use procedures and products recommended by sink and top manufacturers. Remove excess adhesive and sealant while stills wet and finish joint for neat appearance.

3.4 Installation Of Accessories

- .1 Install accessories according to approved Shop Drawings and manufacturer's written instructions.
- .2 Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.
- .3 Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

3.5 Cleaning And Protecting

- .1 Repair or remove and replace defective work as directed on completion of installation.
- .2 Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Construction Manager,
- .3 **Protection:** Provide 6-mil plastic or other suitable water-resistant covering over countertop surfaces. Tape to underside of countertop at minimum of 48 inches on center.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 General: Provide Entrance floor mats and frames in accordance with requirements of the Contract Documents.

1.2 References

- .1 ASTM International (ASTM):
- .1 ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire.
 - .2 ASTM D2047, Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
 - .3 ASTM E648, Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.

1.3 Submittals

- .1 Product Data: Submit for Consultant's action. Furnish each type of product and accessories to be used in the Work; before starting work of this section.
- .1 Submit manufacturer's product data for each type of floor mat and frame specified including; but not limited to, installation instructions.
- .2 Shop drawings: Submit for Consultant's action:
- .1 Shop drawings indicating detailed layout of mat and frame including; but not limited to, details indicating construction relative to materials, direction of traffic, spline locations, profiles, anchors and accessories.
 - .2 Samples: Submit for Consultant's action. Submit samples prior to starting work of this section as follows; accepted samples will form the standard of acceptance for the remainder of the work:
 - .3 Submit 2 samples of floor mat and frame members with specified finish indicating each type of colour for exposed floor mat, frame and accessories required for verification by Consultant.

1.4 Project Closeout Submissions

- .1 Provide operations and maintenance information, and a list of cleaning materials required for maintenance, indicating specific cleaning and maintenance requirements.

1.5 Extra Materials

- .1 Provide extra material that match products installed; packaged with protective covering for storage and identified with labels describing contents.
- .2 Provide entrance mat tiles in full size units equal to 2% amount installed for each size, color, and pattern specified with no fewer than 10 units of each.

1.6 Performance Requirements

- .1 Flammability in accordance with ASTM E648, Class I, Critical Radiant Flux, minimum 0.45 watts/m².
- .2 Slip resistance in accordance with ASTM D2047, Coefficient of Friction, minimum 0.60 for accessible routes tested in wet conditions.

- .3 Standard rolling load performance is 350 lb./wheel with larger loading requirements as specified (load applied to a solid 5" x 2" wide polyurethane wheel, 1000 passes without damage).
- 1.7 Quality Assurance
 - .1 Obtain floor mats and frames from single source by single manufacturer installed by personnel experienced in similar projects and complexity to that specified.
- 1.8 Project Conditions
 - .1 **Field Measurements:** Verify dimensions by field measurements before fabrication and indicate measurements on shop drawings where entrance mat systems are indicated to recesses and other construction.
 - .2 **Established Dimensions:** Establish dimensions and proceed with fabricating entrance mat systems without field measurements where field measurements cannot be made without delaying the Work. Coordinate construction to ensure that actual dimensions correspond to established dimensions; allow for trimming and fitting.
- 1.9 Coordination
 - .1 Coordinate recessed frame installation with Structural, provide measurements for recess size and frame anchorage requirements necessary for installation of entrance mat and frame system.
 - .2 Coordinate top of mat surfaces with bottom of doors swinging across entrance mats and frames, provide information to ensure clearance between mat without impinging operation of door.
 - .3 Coordinate delivery of entrance mat system with building enclosure to ensure that installation conditions are complete and related interior finish work is in progress.
- 2. **PRODUCTS**
 - 2.1 Floor Mats
 - .1 OBEX™ Bars are designed with a unique aluminum click-in system for simple installation directly on premises. Bars can be cut to fit any application—whether surface mounted on the floor or installed in recessed mat wells. Bars feature our Cut textile or Monofilament inserts with added backing for built-in sound insulation.
 - .2 Basis of Design: WM-1 and WM-2 in Section 09 06 00.
 - 2.2 Recessed
 - .1 RECESSED For installation in recessed areas, OBEX Bars combine with start and finish profiles in "J" shape for a perfect finished look..
 - 2.3 Tread Insert Options
 - .1 Frames: Manufacturers standard frame types to suit installation requirements and as detailed on Drawings and as selected by Consultant.
- 3. **EXECUTION**
 - 3.1 Examination
 - .1 Examine areas and conditions where entrance mats and frames are being installed and confirm that conditions detrimental to installation are corrected before starting work of this Section.

3.2 Preparation

- .1 Install levelling grout to screed level required for accurate recessed installation. Refer to Section 09 61 01 for levelling options.
- .2 Fill prepared mat and frame recesses with plywood filler until entrance mats are installed.

3.3 Installation

- .1 Install entrance mat and frame system in accordance with manufacturers written instructions, set at height recommended by manufacturer to achieve effective cleaning action and as follows:
 - .1 Install shims, spacers, and anchorages for proper location and secure attachment of frames.
 - .2 Recessed Installation: Install grout and fill around frames, provide additional levelling screed to set mat tops at correct height above adjacent floor materials and surfaces; finish grout and fill smooth and level.
- .2 Install entrance mats immediately before declaration of Substantial Performance for the project and after construction traffic is completed.
- .3 Install entrance mat and frame in removable sections for ease of maintenance by Owner.

3.4 Maintenance Demonstration

- .1 Train Owner's designated maintenance personnel in the care and upkeep of entrance mats and frames.
- .2 Demonstrate cleaning methods required to maintain entrance mat and frame system, based on estimated foot traffic requirements for the completed project.
- .3 It is important to the life cycle of the entrance mat that a maintenance schedule be developed which includes regular vacuuming and extraction that correctly matches the amount of traffic the mat incurs.

END OF SECTION

1. GENERAL

- .1 **FUTURE installed – Owner will supply and install outside of this Contract. Spec included for information and coordination purposes.**

1.2 Summary

- .1 Provide telescoping chair platforms in accordance with requirements of Contract Documents.
- .2 FUTURE installed – installed outside of this Contract. Spec included for information and coordination purposes.

1.3 Reference standards

- .1 American Society for Testing and Materials (ASTM):
- .1 ASTM A36/A36M, Standard Specification for Carbon Structural Steel
 - .2 ASTM A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
 - .3 ASTM A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
 - .4 ASTM A513/A513M, Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
 - .5 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - .6 ASTM A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
 - .7 ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 - .8 ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 - .9 ASTM D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
 - .10 ASTM F851, Standard Test Method for Self-Rising Seat Mechanisms
- .2 Canadian Standards Association (CSA):
- .1 CSA B651, Accessible Design for the Built Environment
- .3 National Fire Protection Association (NFPA):
- .1 NFPA 101, Life Safety Code
 - .2 NFPA (Fire) 102, Standard for Grandstands, Folding and Telescopic Telescoping chair, Tents, and Membrane Structures

1.4 Submittals

- .1 Product Data: Submit for Consultant's action, product data including, but not limited to, construction details, material descriptions, dimensions of individual components and profiles, and finishes for telescoping chair platforms.
- .2 Shop Drawings: Submit for Consultant's action, shop drawings including, but not limited to plans, elevations, sections, details, and attachments to other work, and as follows:
- .1 Include structural analysis data signed and sealed by a qualified professional engineer, registered in the province of the Work, and who is responsible for the design.
 - .2 Include wiring diagrams for electrically operated units.

- .3 Samples: Submit for Consultant's action, samples to Consultant for verification of design intent for each type of exposed finish required as follows:
 - .1 Decking: 75 mm x 75 mm square samples of finished material.
 - .2 Metal Components: 75 mm x 75 mm square sample of each color and finish indicated.
 - .3 Telescoping chair: 75 mm x 75 mm square sample of each telescoping chair material, color, and finish indicated.
 - .4 Sample of louver grille installed at front of bleacher risers.
 - .5 Sample of fabric at ends, for Consultant to select colour.

 - .4 Certificates: Submit for Consultant's action, product certificates for each type of flame retardant treated fabric indicating class and type of flame retardant, and that telescoping chair platform systems meets or exceeds the minimum structural requirements listed in this Section.
- 1.5 Quality Assurance
- .1 Obtain each type of telescoping chair required, including accessories and mounting components, from single source from single manufacturer; provide equipment incorporating manufacturer's design improvements and materials current at time of shipment, provided that design improvements and materials are consistent with the intent of these specifications.
 - .2 Use installer that is a manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - .3 Design telescoping chair platforms in accordance with NFPA 101 and NFPA 102; specifically Chapter 5, Folding and Telescopic Telescoping chair, except as otherwise required by the local Authorities Having Jurisdiction, using a qualified professional engineer and as follows:
 - .1 Design telescopic telescoping chair to support its own weight and the weight of added accessories for a uniformly distributed live load of not less than 4.8 kN/m² of gross horizontal projection:
 - .1 Allow for seat boards and footrests for a live load of not less than 1.8 kN/m.
 - .2 Allow for a sway force applied to seats of 350 N/m parallel to seats and 146 N/m perpendicular to the seats; do not consider sway forces as simultaneously applied.
 - .2 Design railings, posts and sockets withstand the following forces applied separately:
 - .1 Allow for a concentrated load of 890 N applied at any point and in any direction; and a uniform load of 730 N/m applied in any direction for handrails; concentrated and uniform loading conditions are not required to be applied simultaneously.
 - .2 Guards shall be designed and constructed to withstand a 3.0 kn load, in accordance with National Building Code.
 - .4 Perform welding in accordance with and use personnel qualified by Canadian Welding Bureau for classification of work being performed for structural welding for steel and steel sheet.
 - .5 Supply electrical components, devices, and accessories in accordance with the Canadian Electrical Code; tested by a qualified testing agency; and marked for intended location and application.
 - .6 Supply telescoping chair platforms meeting the requirements of CSA B651 for accessible design.
 - .7 Supply fixed folding seats for arena and chair material having fire test response characteristics as follows:
 - .1 Plastic: Polyethylene in accordance with ASTM D635, and having a burning rate of 25 mm/minute or less.

1.6 Project Conditions

- .1 **Field Measurements:** Verify actual dimensions of telescoping chair layout and adjacent construction affecting installation of telescoping chair by field measurements before starting fabrication; indicate field measurements on shop drawings.

1.7 Coordination

- .1 Coordinate layout and installation of electrical wiring and devices with telescoping chair layout to ensure that floor junction boxes for electrical devices are accurately located to allow connection without exposed conduit.
- .2 Coordinate connection of wiring and devices installed in telescoping chair with requirements in Division 26 Sections.

1.8 Warranty

- .1 Provide manufacturer's warranty indicating that manufacturer agrees to repair or replace components of telescoping chair platform systems that fail in materials or workmanship for a period of one (1) year for the date of Substantial Performance for the Project.
- .2 Failures will be considered to include, but are not limited to, the following:
 - .1 Structural failures including mounting standards.
 - .2 Faulty operation of self rising seat mechanism.
 - .3 Faulty operation of electrical components.
 - .4 Deterioration of metals, metal finishes, and other materials beyond normal use.

2. PRODUCTS

2.1 Manufacturers

- .1 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 Hussey Seating Ltd.
 - .2 Interkal LLC
 - .3 Irwin Telescopic Seating Ltd.

2.2 Materials

- .1 Steel:
 - .1 Structural-Steel Shapes, Plates, and Bars: ASTM A36.
 - .2 Uncoated Steel Strip; Non-Structural Components: ASTM A569, Commercial Quality, Type B, Hot-Rolled Strip.
 - .3 Uncoated Steel Strip; Structural Components: ASTM A570 Grade 33 (228 MPa), Grade 40 (276 MPa), Grade 45 (311 MPa), or Grade 50 (345 MPa), Structural Quality, Hot-Rolled.
 - .4 Uncoated Steel Strip (Structural Components): ASTM A607 Grade 45 or 50, High-Strength, Low Alloy, Hot-Rolled Strip
 - .5 Galvanized Steel Strip: ASTM A653 Grade 40 (276 MPa), structural quality, coating designation G60.
 - .6 Tubing: ASTM A500, cold formed; Grade B.
- .2 Wood:
 - .1 Lumber: ANSI/Voluntary Product 20, B & B Southern Pine
 - .2 Plywood: ANSI/Voluntary Product PS1, APA A-C Exterior Grade.

- .3 Polyethylene Polymer: ASTM D 1248, Type III, Class B; molded, color-pigmented, textured, impact-resistant, structural formulation.
- .4 Fasteners: Vibration proof; size and material standard with manufacturer.
- 2.3 Telescoping chair platform systems
 - .1 Wall Attached Telescoping Chair Platforms: Rear of under structure permanently attaches to wall construction, and as follows:
 - .1 Basis-of-Design Product: MAXAM+, Hussey Seating, Metro Wall Attached Telescopic Platform Chair System
 - .2 Chair Platform Configuration: As detailed on Drawings.
- 2.4 Understructure
 - .1 Finish: Rust-inhibiting black finish.
 - .2 Deck System:
 - .1 Nose beam and Rear Riser beam: Nose beam continuously roll-formed closed tubular shape of ASTM A653 grade 40 (276 MPa). Riser beam continuously roll-formed of ASTM A653 grade 40 (276 MPa). Nose and Riser beam designed with no steel edges exposed to spectator after product assembly. Nose beam and riser beams are through-bolted fore/aft to deck stabilizers and frame cantilevers to create the deck structure.
 - .2 Classic Wood Deck: 19 mm, AC grade clear-top-coated tongue and groove Southern Yellow Pine; or BC grade polyethylene-top-coated tongue and groove Douglas Fir plywood; both of interior type with exterior glue, 5-ply, all plies with plugged cross-bands, produced in accordance with National Bureau of Standards PS-1-97. Plywood cut and installed with top, center and bottom ply grain-oriented from front of deck to rear of deck (nose beam to riser beam). Adjacent pieces locked together with tongue and groove joint from front to rear of deck. Longest unsupported span: 724 mm.
 - .3 Frame System:
 - .1 Lower Track subassembly: ASTM A1011 Grade 50: Continuous Positive Interglide System (casterhorn) interlocks each adjacent frame casterhorn using an integral, continuous, anti-drift feature and captive interlock with adjustable row spacing at front to prevent separation and misalignment.
 - .2 Wheels: Not less than **127 mm** diameter by **32 mm** with non-marring soft rubber face to protect wood and synthetic floor surfaces, with molded-in sintered iron oil-impregnated bushings to fit **10 mm** diameter axles secured with E-type snap rings.
 - .3 Slant Columns: High tensile steel, tubular shape.
 - .4 Sway Bracing: ASTM A653 grade 40 (276 MPa), tension members bolted to columns.
 - .5 Deck Stabilizer: A1011 Grade 45, member through-bolted to nose and riser at three locations per section. Securely captures front and rear edge of decking at rear edge of nose beam and lower edge of riser beam for entire length of section. Interlocks with adjacent stabilizer on upper tier using low-friction nylon roller to prevent separation and misalignment.
 - .4 Lock system: Casterhorns at the end sections of powered banks (minimally), and manual sections, contain a Low Profile Posi-Lock LX to lock each row in open position and allow unlocking automatically. Provide adjustable stops to allow field adjustment of row spacings.
- 2.5 Seating
 - .1 Seating Chairs:
 - .1 Textured one-piece gas-assist injection molded pigmented polypropylene shells.
 - .2 Upholstery: complete self-retaining unit, welded to the seat and back surfaces using a hot plate welding technique.

- .1 Each unitized upholstery panel comprised of medium density virgin urethane foam on a precision injection molded polypropylene backer. Fabric cover tensioned over and neatly enclose both foam and backer.
- .2 Covers: three-piece construction, without welts, taut, and securely retained.
- .3 Upholstery: Grade G Upholstery Material, fabric colour selected from manufactures standard range.
- .3 Seat and Back: internal structured with peripheral gas channel frame. Frames support, resist, and transmit design loads to the aluminum chair beam.
- .4 Seat foam cushion: Minimum 38.1 mm thick; back foam cushion minimum 25.4 mm thick.
- .5 Seat (bottom) closure: textured plastic with front and sides turned 180 degrees to regain and protect cover. Pan materials, texture, and color to match chair back; non-matching seat pan/back construction materials and finishes are not acceptable.
- .2 Armrests: Injection-molded, leather textured polypropylene secured to polypropylene armrest base with concealed fasteners.
- .3 Chair Beam: Extruded aluminum with polymer end caps and serve as the focal attachment and transmit forces to the beam support.
- .4 Beam support: Cast steel support arms. Design top of support arms to capture and secure the beam in place. Support arms articulate from manual assist or semi-automatic operating mechanism.
- 2.6 Electrical Operation
 - .1 Operation: Automatic and as follows:
 - .1 Limit Switches: Automatically stop integral power system when telescoping chair platforms reach fully opened or closed positions.
 - .2 Transformer: As required to coordinate electrical requirements of motor and control station with building electrical system.
 - .3 Control Pack: Operation with removable pendant control unit plugs into seating bank for operator management of stop, start, forward, and reverse control of the power operation. Each unit for PF(1/2/3/4) is driven by a 1/2 horsepower, 1725 RPM motor.
 - .1 208V 3 Phase:
 - This 1.25 Service Factor motor runs on 208V at 60 Hz and draws a full load current of 2.2 amperes. The required power supply shall be 3 asynchronous phases of 120 Volts each, plus neutral plus ground, each with 20 Amp capacity.
 - This system shall be UL Listed in its entirety (motors, circuit protection, motor controls, user interface, enclosures, conductors and connectors all evaluated and approved for correct sizing and compatibility under maximum rated load on the motors) under UL Product Category FHJU, titled Electrical Drive and Controls for Folding and Telescopic Seating.
- 2.7 Finishes
 - .1 Metal Finishes:
 - .1 Finish exposed metal parts using manufacturer's standard baked on polyurethane or polyester coating having a minimum 0.04 mm thickness.
 - .2 Colour: As selected by Consultant from manufacturer's full range.
 - .2 Plastic Materials: High density, high impact resistant blow moulded linear polyethylene with ultraviolet light inhibitors to retard fading and fire retardant in accordance with ASTM D635.
 - .3 Railings: Structural steel, finished with manufacturer's standard powder coat system; colour: As selected by Consultant from manufacturers standard range.

3. EXECUTION

3.1 Examination

- .1 Examine areas where telescoping chair platforms are being installed for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

- .1 Install telescoping chair platforms in accordance with referenced safety standard and manufacturer's written instructions.
- .2 Coordinate with Section 09 64 66 for blocking under floor in locations of telescoping chair platforms.

3.3 Field Quality Control

- .1 Engage a factory authorized service representative to inspect components, assemblies, and equipment installations including connections to power receptacles; prepare a written test and inspection report and submit to Consultant indicating corrective measures taken to repair or replace deficient materials.

3.4 Adjusting and Cleaning

- .1 Lubricate, test, and adjust each telescoping chair platform so that it operates according to manufacturer's written operating instructions on completion of installation.
- .2 Clean installed telescoping chair platforms on exposed and semi-exposed surfaces.
- .3 Touch up shop applied finishes or replace components as required to restore damaged or soiled areas.

3.5 Demonstration

- .1 Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain telescoping chair platforms.
- .2 Inform Owner of NFPA 102 requirement to have telescoping chair platforms inspected on an annual basis.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 01 91 13.13 - Commissioning Plan
- .3 Section 01 91 13.16 - Commissioning Forms
- .4 Section 01 91 14 - Facility Commissioning Mechanical
- .5 Section 01 91 15 - Facility Commissioning Electrical
- .6 Section 09 91 00 - Painting
- .7 Section 21 12 01 - Portable Fire Extinguishers
- .8 Section 21 13 13 - Wet Pipe Sprinkler Systems
- .9 Section 21 30 00 - Fire Pumps
- .10 Section 23 05 02 - Pipework Testing
- .11 Section 23 05 00 - Common Work Results for HVAC
- .12 Section 23 05 01 - Use of HVAC Systems During Construction
- .13 Section 23 05 02 - Pipework Testing
- .14 Section 23 05 03 - Mechanical Start-Up
- .15 Section 23 05 13 - Common Motor Requirements for HVAC Equipment
- .16 Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .17 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .18 Section 23 05 48 - Vibration and Seismic Controls for HVAC
- .19 Section 23 05 53 - Identification for HVAC Piping and Equipment
- .20 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC
- .21 Section 23 08 16 - Cleaning and Start-up of HVAC Piping Systems

1.2 REFERENCE STANDARDS

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 10-2022 - Standard for Portable Fire Extinguishers
 - .2 NFPA 13-2022, Standard for the Installation of Sprinkler Systems.
 - .3 NFPA 20-2022, Standard for the Installation of Stationary Pumps for Fire Protection.
 - .4 NFPA 25-2022, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
- .2 National Fire Code of Canada (NFCC 2020)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for all fire protection equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Where required, submit drawings stamped and signed by professional engineer registered or licensed in Yukon Territory, Canada.
 - .2 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .4 In addition to transmittal letter referred to in Section 01 00 10 - General Requirements: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Operation and Maintenance Data: submit operation and maintenance data for fire protection equipment for incorporation into manual.
 - .1 Provide 1 complete sets of hard copy and 1 soft copy Operation and Maintenance manual prior to system or equipment tests.
 - .2 Operation and Maintenance manual to be approved by Consultant and Owner, and 4 final hard copies and 1 soft copy deposited with Owner before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.

- .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
 - .1 Submit electronic copies of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed by Consultant.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
 - .1 Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .9 As-Built drawings:
 - .1 Prior to start of Start-up and Commissioning of Fire Protection Systems, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows:

AS BUILT DRAWINGS: THIS DRAWING
HAS BEEN REVISED TO SHOW FIRE
PROTECTION SYSTEMS AS INSTALLED

(Signature of Contractor) (Date)
 - .3 Submit to Consultant for approval and make corrections as directed.
 - .4 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Furnish spare parts as follows:
 - .1 One set of packing for each pump.

- .2 One casing joint gasket for each size pump.
- .3 One glass for each gauge glass.
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 00 10 - General Requirements

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of packaging materials, crates, padding, pallets as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

1.7 FIRE PROTECTION COST BREAKDOWN

- .1 Provide detailed breakdown of Fire Protection Sub-Contractor's work prior to first progress claim. Breakdown to be itemized with separate labour and material listing against each item of the contract breakdown. After approval by Consultant cost breakdown will be used as basis for progress payment.
- .2 Breakdown and subsequent Progress Claims are to be itemized with separate labour and material listing against each item of the contract breakdown where indicated as required.
- .3 Progress claims will not be reviewed if they do not breakout materials and labour where appropriate.
- .4 Fire Protection Contract Breakdown:
 - .1 General
 - .1 Mobilization / Demobilization
 - .2 Administration & Safety
 - .3 Hydrant Flow Test
 - .4 Fire protection engineering and construction drawings
 - .5 Shop drawings
 - .2 Systems & Equipment
 - .1 Fire Extinguishers
 - .2 Fire Pump
 - .3 Sprinkler Tree

- .4 Sprinkler Piping, Fittings, and Valves.
- .5 Sprinkler Heads
- .3 Documentation & Closeout
 - .1 Seismic Restraints
 - .2 Testing and Balancing
 - .3 Performance Verification
 - .4 Commissioning
 - .5 Operation & Maintenance Manuals
 - .6 As-built drawings
 - .7 Training
 - .8 Warranty Review
- .5 Fire Alarm System Contract Breakdown
 - .1 Refer to Section 26 05 00 - Common Work Results for Electrical

Part 2 Products - Not Used

Part 3 Execution

3.1 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 00 - Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.2 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 00 10 - General Requirements and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.3 DEMONSTRATION & TRAINING

- .1 Consultant will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

- .4 Instruction duration time requirements as specified in appropriate sections as supplemented with minimum training requirements as follows:
 - .1 Division 22 items: refer to Section 22 05 00 - Common Work Results for Plumbing
 - .2 Division 23 items: refer to Section 23 05 00 - Common Work Results for Mechanical
 - .3 Division 25 items: refer to Section 25 01 12 - EMCS: Training
 - .4 Fire extinguishers: 30 minutes
 - .5 Fire protection system backflow preventers: 1 hour
 - .6 Wet pipe sprinkler system, including sprinkler tree: greater of 2 hours or as required by NFPA 13
 - .7 Fire pump package: refer to Section 21 30 00 - Fire pumps

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 21 05 00 - Common Work Results for Fire Suppression

1.2 REFERENCES

- .1 National Fire Protection Association (NFPA)
 - .1 National Fire Protection Association (NFPA)
- .2 Canadian General Standards Board (CGSB)
 - .1 Canadian General Standards Board (CGSB)
- .3 National Fire Code of Canada (NFCC 2020)

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 00 10 - General Requirements

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 MULTI-PURPOSE DRY CHEMICAL EXTINGUISHERS

- .1 Stored pressure rechargeable type with hose and shut-off nozzle, ULC labelled for A, B and C class protection.
- .2 Extinguishing agent: fluidized and siliconized mono ammonium phosphate powder, non conductive.
- .3 Construction: ULC approved steel cylinder, metal valves and siphon tubes, replaceable molded stem seals, pull-push pin upright squeeze operation, pressure gauge.
- .4 Finish: corrosion and impact resistant polyester/epoxy paint finish.
- .5 Operating temperature range: -54degC to 49degC.
- .6 Size: as noted in schedule
- .7 Schedule: see drawings

- .8 Acceptable material: Ansul Sentry, Amerex, Strike First

2.2 CLEAN AGENT EXTINGUISHERS

- .1 General: pressurized, rechargeable, clean agent extinguisher labeled for A, B and C class protection.
- .2 Approvals: ULC
- .3 Extinguishing agent: EPA SNAP approval, clean agent, non conductive, agent to not cause thermal shock to equipment.
- .4 Construction: seamless, steel cylinder, aluminum alloy valve body and hose ferrules, steel pick up tubes, pull-push pin upright squeeze operation, pressure gauge, 100% leak tested.
- .5 Finish: corrosion and impact resistant two coat powder paint, shot blast prior to painting.
- .6 Operating temperature range: -40degC to 49degC.
- .7 Size: as noted in schedule
- .8 Schedule: see drawings
- .9 Acceptable material: Ansul Cleanguard, Amerex, Strike First

2.3 EXTINGUISHER BRACKETS

- .1 Type recommended by extinguisher manufacturer.
- .2 Schedule:
 - .1 Standard hanger with quick release mechanical retention strap; Or
 - .2 As noted on drawing schedule.
- .3 Acceptable material: Ansul, Larsen's, Amerex, Strike First.

2.4 CABINETS

- .1 Semi-recessed type as indicated, constructed of 1.6 mm thick steel, 13mm thick hollow metal gauged door, 180 degrees opening, 100mm rolled edge, recessed satin finish pull handle, continuous hinge and self adjusting roller catch.
- .2 Cabinet to maintain fire resistive rating of construction in which they occur.
- .3 Cabinet door: with clear acrylic protruding bubble such that extinguisher visible through door for 180 degrees.
- .4 Finish:
 - .1 Tub: prime coated.
 - .2 Door and frame: Standard white backed enamel finish.
- .5 Dimensions to suit extinguisher but not less than:
 - .1 Inside box: 610H x 240W x 89D.
 - .2 Outside trim: 699H x 330W.
 - .3 Rough Opening: 635H x 267W x 38D.
- .6 Acceptable material: Larsen's C2409-6R

2.5 IDENTIFICATION

- .1 Identify extinguishers in accordance with recommendations of NFPA 10.
- .2 Attach tag or label to extinguishers, indicating month and year of installation. Provide space for service dates.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install or mount extinguishers in cabinets or on brackets as indicated and as required by ANSI/NFPA 10
 - .1 Install extinguishers in semi- recessed cabinets where indicated on drawings by designator (SR).
 - .2 Except where otherwise indicated all Type DCE-1 extinguishers to be installed in Semi-recessed cabinets.
 - .1 Within the lab spaces, all Type DCE-1 extinguishers to be installed on specified wall hangers for quick access.
 - .3 All Type DCE-2 extinguishers to be installed on specified wall hangers.
 - .4 All Type DCE-3 extinguishers to be installed on specified wall hangers.
- .2 Mounting height shall be as indicated on the architectural plans but in no case shall the mounting height exceed 1500mm above finished floor to the top of the extinguisher for extinguishers with a gross weight up to and including 20 kg. Where otherwise not indicated mounting height shall be 1200mm to the top of the extinguisher.
- .3 Confirm and mark on tag serviceability prior to substantial.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 00 - Common Work Results for Fire Suppression.
- .2 Section 21 30 00 - Fire Pumps
- .3 Section 26 05 00 - Common Work Results for Electrical
- .4 Section 28 31 00 - Fire Detection and Alarm

1.2 REFERENCE STANDARDS

- .1 National Fire Prevention Association (NFPA)
 - .1 NFPA 13-2022, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 20-2022, Standard for the Installation of Stationary Pumps for Fire Protection.
 - .3 NFPA 25-2022, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
- .2 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN4 S543-M984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Yukon Territory of Canada.
 - .2 Indicate:
 - .1 Materials.
 - .2 Finishes.
 - .3 Method of anchorage
 - .4 Number of anchors.
 - .5 Supports.
 - .6 Reinforcement.
 - .7 Assembly details.
 - .8 Accessories.
- .4 Test reports:
 - .1 Submit certified test reports for wet pipe fire protection sprinkler systems from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

- .5 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Manufacturers' Instructions:
 - .1 Provide manufacturer's installation instructions.
- .7 Field Quality Control Submittals:
 - .1 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 00 10 - General Requirements in accordance with NFPA 13 and NFPA 20.
- .2 Manufacturer's catalogue Data, including specific model, type, and size for:
 - .1 Pipe and fittings.
 - .2 Alarm valves.
 - .3 Valves, including gate, check, and globe.
 - .4 Sprinkler heads.
 - .5 Pipe hangers and supports.
 - .6 Pressure or flow switch.
 - .7 Fire department connections.
 - .8 Excess pressure pump.
 - .9 Mechanical couplings.
- .3 Drawings:
 - .1 Sprinkler heads and piping system layout.
 - .1 Prepare 760 mm by 1050 mm detail working drawings of system layout in accordance with NFPA 13, "Working Drawings (Plans)".
 - .2 Show data essential for proper installation of each system.
 - .3 Show details, plan view, elevations, and sections of systems supply and piping.
 - .4 Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams.
 - .2 Electrical wiring diagrams.
- .4 Design Data:
 - .1 Calculations of sprinkler system design.
 - .2 Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months.
- .5 Field Test Reports:
 - .1 Preliminary tests on piping system.
- .6 Records:
 - .1 As-built drawings of each system.

- .1 After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes.
- .2 Submit 760 mm by 1050 mm drawings on reproducible Mylar film with title block similar to full size contract drawings.
- .7 Operation and Maintenance Manuals:
 - .1 Provide detailed hydraulic calculations including summary sheet, and Contractors Material and Test Certificate for aboveground piping and other documentation for incorporation into manual in accordance with NFPA 13.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: company or person specializing in wet sprinkler systems with documented experience of at least 5 years.
 - .2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 00 10 - General Requirements
 - .2 Provide spare sprinklers and tools in accordance with NFPA 13.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Storage and Protection:
 - .1 Store materials in dry location indoors.
 - .2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 DESIGN REQUIREMENTS

- .1 Design automatic wet pipe fire suppression sprinkler systems in accordance with required and advisory provisions of NFPA 13, by hydraulic calculations for uniform distribution of water over design area.
- .2 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.

- .3 Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings.
- .4 Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers.
- .5 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.
- .6 Design systems for earthquake protection for buildings in seismic zones 3 and 4, and only essential and high risk buildings in seismic zone 2.
- .7 Location of Sprinkler Heads:
 - .1 Locate heads in relation to ceiling and spacing of sprinkler heads not to exceed that permitted by NFPA 13 for Light and Ordinary hazard occupancies.
 - .2 Uniformly space sprinklers on branch.
- .8 Water Distribution:
 - .1 Make distribution uniform throughout the area in which sprinkler heads will open.
 - .2 Discharge from individual heads in hydraulically most remote area to be 100 % of specified density.
- .9 Density of Application of Water:
 - .1 Size pipe to provide specified density when system is discharging specified total maximum required flow.
 - .2 Application to horizontal surfaces below sprinklers shall be as defined in NFPA 13.
- .10 Sprinkler Discharge Area:
 - .1 Area: hydraulically most remote area as defined in NFPA 13.
- .11 Outside Hose Allowances:
 - .1 Include allowance in hydraulic calculations of 568 lpm for outside hose streams.
- .12 Friction Losses:
 - .1 Calculate losses in piping in accordance with Hazen-Williams formula with 'C' value of 120 for steel piping, 150 for copper tubing, and 140 for cement-lined ductile-iron piping.
- .13 Water Supply:
 - .1 Contractor to arrange for and pay for a fire hydrant flow test to obtain static pressure, flow rate and residual pressure at junction with municipal water distribution piping system.

2.2 ABOVE GROUND PIPING SYSTEMS

- .1 Provide fittings for changes in direction of piping and for connections.
 - .1 Make changes in piping sizes through tapered reducing pipe fittings, bushings will not be permitted.
- .2 Perform welding in shop; field welding will not be permitted.
- .3 Conceal piping in areas with suspended ceiling.

2.3 PIPE, FITTINGS AND VALVES

- .1 Pipe:
 - .1 Ferrous: to NFPA 13.
 - .2 Copper tube: to NFPA 13.
- .2 Fittings and joints to NFPA 13:
 - .1 Ferrous: screwed, welded, flanged or roll grooved.
 - .1 Grooved joints designed with two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.
 - .2 Copper tube: screwed, soldered, brazed, grooved.
 - .3 Provide welded, threaded, grooved-end type fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded.
 - .4 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will not be permitted.
 - .5 Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 32 mm and larger.
 - .6 Fittings: ULC approved for use in wet pipe sprinkler systems.
 - .7 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.
 - .8 Side outlet tees using rubber gasketed fittings are not permitted.
 - .9 Sprinkler pipe and fittings: metal.
- .3 Valves:
 - .1 ULC listed for fire protection service.
 - .2 Gate valves: open by counterclockwise rotation.
 - .3 Provide OS & Y valve beneath each alarm valve in each riser when more than one alarm valve is supplied from same water supply pipe.
 - .4 Check valves: flanged clear opening swing or spring actuated check type with flanged inspection and access cover plate for sizes 10 cm and larger.
- .4 Pipe hangers:
 - .1 ULC listed for fire protection services in accordance with NFPA.

2.4 BACK FLOW PREVENTERS

- .1 Fire Protection System: Double Check Valve Assembly
 - .1 Approvals: ULC and FM approved and to CSA B64.4
 - .2 Construction: Double check valve assembly backflow preventer, tri-link check modules with reversible elastomer discs that provide drip-proof closure against backflow and back-siphonage, type 304 stainless steel housing with a sleeved access port, full port ball valve test cocks, line size OS&Y isolation valves upstream and downstream of assembly.
 - .3 Max working pressure: 1205 kPa.
 - .4 Temperature range: 0.5°C to 60°C

- .5 Size: line size.
- .6 Configuration: straight pattern.
- .7 Application: fire protection backflow prevention.
- .8 Acceptable Material: Watts series 757, Zurn

2.5 SPRINKLER HEADS

- .1 General Requirements: Sprinkler heads complying with NFPA 13, ULC listed, and approved for fire protection service.
- .2 Sprinkler guard for sprinkler exposed to mechanical shock, with zinc coated steel rod, provided by the same manufacturer as the sprinkler it protects.
- .3 Upright Sprinklers:
 - .1 Upright sprinkler, quick response, with frangible bulb, "K" factor of 5.6 (S-01):
 - .1 Acceptable products:
 - .1 Viking Microfast, model M, VK-3001.
 - .2 Victaulic, style V2704.
 - .3 Tyco, model TY3131.
 - .2 Temperature ratings: 68 °C, 93 °C, 141 °C, as needed or as indicated on drawings.
 - .3 Finish: Bronze, brass, white polyester, black polyester, color as selected by the Architect, or as indicated on drawings.
 - .4 Maximal sprinkler coverage:
 - .1 Light hazard:
 - .1 Maximal coverage: 20.9 m2.
 - .2 Maximal distance between heads: 4.6 m.
 - .2 Ordinary hazard:
 - .1 Maximal coverage: 12.1 m2.
 - .2 Maximal distance between heads: 4.6 m.
- .4 Pendant Sprinklers:
 - .1 Recessed pendant sprinklers, with recessed escutcheon, quick response, with frangible bulb, "K" factor of 5.6 (S-02):
 - .1 Acceptable products:
 - .1 Viking Microfast, model M, VK-3021.
 - .2 Victaulic, style V2708.
 - .3 Tyco, model TY3231
 - .2 Pendant sprinklers, without recessed escutcheon, quick response, with frangible bulb, "K" factor of 5.6 (S-03):
 - .1 Acceptable products:
 - .1 Viking Microfast, model M, VK-3021
 - .2 Victaulic, style V2708
 - .3 Tyco, model TY3231

- .3 Pendant sprinklers, dry type, quick response, with frangible bulb, "K" factor of 5.6 (S-04):
 - .1 Acceptable products:
 - .1 Viking QR dry adjustable STD, VK 176;
 - .2 Victaulic, style V3606;
 - .3 Tyco, model TY3235;
 - .4 Temperature ratings: 68 °C, 93 °C, 141 °C, as needed or as indicated on drawings.
 - .5 Finish: Bronze, brass, white polyester, black polyester, color as selected by the Architect, or as indicated on drawings.
 - .6 Maximal sprinkler coverage:
 - .1 Light hazard:
 - .1 Maximal coverage: 20.9 m2.
 - .2 Maximal distance between heads: 4.6 m.
 - .2 Ordinary hazard:
 - .1 Maximal coverage: 12.1 m2.
 - .2 Maximal distance between heads: 4.6 m.
- .5 Sidewall Sprinklers:
 - .1 Sidewall sprinklers, quick response, with frangible bulb, "K" factor of 5.6 (S-05):
 - .1 Acceptable products:
 - .1 Viking Microfast, model M, VK-305;
 - .2 Victaulic, style V2710;
 - .3 Tyco, model TY3331;
 - .2 Temperature ratings: 68 °C, 93 °C, 141 °C, as needed or as indicated on drawings.
 - .3 Finish: Brass or as indicated on drawings.
 - .4 Maximal sprinkler coverage:
 - .1 Maximal coverage: 20.9 m2.
 - .2 Maximal distance between heads: 4.6 m.

2.6 ALARM CHECK VALVE

- .1 Alarm check valve to NFPA 13 and ULC listed for fire service.
- .2 Provide variable pressure type alarm valve complete with alarm shutoff valve, drain valve, pressure gauges, retarding chamber, alarm test valve, accessories, appurtenances for proper operation of system.
- .3 Provide valve complete with internal components that are replaceable without removing the valve from the installed position.

2.7 SUPERVISORY SWITCHES

- .1 General: to NFPA 13 and ULC listed for fire service.
- .2 Valves:

- .1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.
- .3 Pressure or flow switch type:
 - .1 With normally open and normally closed contacts and supervisory capability.
 - .2 Provide switch with circuit opener or closer for automatic transmittal of alarm over facility fire alarm system.
 - .3 Connect into building fire alarm system.
 - .4 Connection of switch: Section 28 31 00 - Fire Detection and Alarm.
 - .5 Alarm actuating device: mechanical diaphragm controlled retard device adjustable from 10 to 60 seconds and instantly recycle.
- .4 Pressure alarm switch:
 - .1 With normally open and normally closed contacts and supervisory capability.

2.8 FIRE DEPARTMENT CONNECTION

- .1 Provide connections approximately 1.5 m above finish grade, location as indicated.
- .2 To NFPA 13 and ULC S543 listed, Siamese type.
- .3 Polished exposed bronze of approved two-way type with 2.5 inch National Standard female hose threads with plug, chain, and identifying fire department connection escutcheon plate.
- .4 Thread specifications: compatible with local fire department.
- .5 Install a 90-degree elbow with drain connection at the low-point near each fire department connection to allow for system drainage to prevent freezing.

2.9 EXCESS PRESSURE PUMP

- .1 Provide where sprinkler tree is NOT SUPPLIED by a fire pump/jockey pump package.
- .2 Provide pumps on each sprinkler piping riser.
- .3 Pumps:
 - .1 Pumps: positive displacement, gear type rated at 1 lpm, integrally mounted with motor.
 - .2 Double acting displacement type, open cylinder design, direct drive, ULC listed, complete with relief valve.
- .4 Pump and motor unit:
 - .1 Approved for automatic wet pipe fire extinguishing sprinkler systems; complete with pilot light panel, differential motor control switch, high pressure switch, and low pressure switch.
 - .2 EEMAC Class B squirrel cage induction 1725 rpm, continuous duty, drip proof, ball bearing, maximum temperature rise 50 degrees C, 0.25 kW, 120/1/60.
 - .3 Capacity: 7.6 L/min.
- .5 Provide electrical power supply connections for pump and pilot light panel at supply side of building service panel.
- .6 Provide separate fused safety-type switch with locked lever for each connection.
- .7 Provide pressure pump sensing piping in supply piping upstream of fire pump.

- .8 Pump operation switch: to operate excess pressure pump with pressure differential of 103 kPa.
- .9 Shut-off valve and strainer on pump inlet. Relief valve, check valve and shut-off valve on discharge connections.

2.10 PRESSURE GAUGES

- .1 ULC listed and to Section 23 05 19.13 - Thermometers and Pressure Gauges.
- .2 Maximum limit of not less than twice normal working pressure at point where installed.

2.11 PIPE SLEEVES

- .1 Provide pipe sleeves where piping passes through floors.
- .2 Secure sleeves in position and location during construction.
- .3 Provide sleeves of sufficient length to pass through entire thickness of floors.
- .4 Provide 2.5 cm minimum clearance between exterior of piping and interior of sleeve or core-drilled hole.
 - .1 Firmly pack space with mineral wool insulation.
 - .2 Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to firm but pliable mass,.
 - .3 In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled holes with ULC listed fill, void, or cavity material.
- .5 Sleeves in Masonry and Concrete Walls, Floors, and Roofs:
 - .1 Provide hot-dip galvanized steel sleeves.
 - .2 Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in core-drilled hole are completely grouted smooth.
- .6 Sleeves in Other Than Masonry and Concrete Walls, Floors, and Roofs:
 - .1 Provide 0.61 mm thick galvanized steel sheet.

2.12 ESCUTCHEON PLATES

- .1 Provide one piece or split hinge type metal plates for piping passing through walls, floors, and ceilings in exposed spaces.
- .2 Provide polished chromium-plated finish on copper alloy plates in finished spaces.
- .3 Provide paint finish on metal plates in unfinished spaces.

2.13 INSPECTOR'S TEST CONNECTION

- .1 Locate inspector's test connection at hydraulically most remote part of each system, provide test connections approximately 3 m above floor for each sprinkler system or portion of each sprinkler system equipped with alarm device.
- .2 Provide test connection piping to location where discharge will be readily visible and where water may be discharged without property damage.
- .3 Provide discharge orifice of same size as corresponding sprinkler orifice.

2.14 SIGNS

- .1 Attach properly lettered Bilingual and approved metal signs to each valve and alarm device to NFPA 13.
- .2 Permanently fix hydraulic design data nameplates to riser of each system.

2.15 ANTIFREEZE

- .1 Antifreeze loops to NFPA 13, locations as indicated.

2.16 SPARE PARTS CABINET

- .1 Provide metal cabinet with extra sprinkler heads and sprinkler head wrench adjacent to each alarm valve. Number and types of extra sprinkler heads as specified in NFPA 13.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Install, inspect and test to acceptance in accordance with NFPA 13 and NFPA 25.

3.3 PIPE INSTALLATION

- .1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.
- .2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.
- .3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.
- .4 Inspect piping before placing into position.

3.4 ELECTRICAL CONNECTIONS

- .1 Provide electrical work associated with this section under Section 26 05 00 - Common Work Results for Electrical.
- .2 Provide fire alarm system under Section 28 31 00 - Fire Detection and Alarm.
- .3 Provide control and fire alarm wiring, including connections to fire alarm systems, in accordance with National Electrical Code.
- .4 Provide wiring in rigid metal conduit or intermediate metal conduit.

3.5 DISINFECTION

- .1 Disinfect new piping and existing piping.
- .2 Fill piping systems with solution containing minimum of 50 parts per million of chlorine and allow solution to stand for minimum of 24 hours.

- .3 Flush solution from systems with clean water until maximum residual chlorine content is not greater than 0.2 part per million or residual chlorine content of domestic water supply.
- .4 Obtain at least two consecutive satisfactory bacteriological samples from piping, analyzed by certified laboratory, and submit results prior to piping being placed into service.

3.6 FIELD PAINTING

- .1 Clean, pretreat, prime, and paint new systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories.
- .2 Apply coatings to clean, dry surfaces, using clean brushes.
- .3 Clean surfaces to remove dust, dirt, rust, and loose mill scale.
- .4 Immediately after cleaning, provide metal surfaces with 1 coat of pretreatment primer applied to minimum dry film thickness of 0.3 ml, and one coat of zinc chromate primer applied to minimum dry film thickness of 1.0 ml.
- .5 Shield sprinkler heads with protective covering while painting is in progress.
- .6 Upon completion of painting, remove protective covering from sprinkler heads.
- .7 Remove sprinkler heads which have been painted and replace with new sprinkler heads.
- .8 Provide primed surfaces with following:
 - .1 Piping in Finished Areas:
 - .1 Provide primed surfaces with 2 coats of paint to match adjacent surfaces.
 - .2 Provide valves and operating accessories with 1 coat of red alkyd gloss enamel applied to minimum dry film thickness of 1.0 mil.
 - .3 Provide piping with self-adhering red plastic bands spaced at maximum of 5 m intervals throughout piping systems.
 - .2 Piping in Unfinished Areas:
 - .1 Provide primed surfaces with one coat of red alkyd gloss enamel applied to minimum dry film thickness of 1.0 mil in mechanical equipment room, spaces above suspended ceilings, spaces where walls or ceiling are not painted or not constructed of a prefinished material.
 - .2 Provide piping with self-adhering red plastic bands spaced at maximum of 5 m intervals.

3.7 FIELD QUALITY CONTROL

- .1 Site Test, Inspection:
 - .1 Perform test to determine compliance with specified requirements in presence of Consultant or their designated representative. .
 - .2 Test, inspect, and approve piping before covering or concealing.
 - .3 Preliminary Tests:
 - .1 Hydrostatically test each system at 200 psig for a 2 hour period with no leakage or reduction in pressure.
 - .2 Flush piping with potable water in accordance with NFPA 13.

- .3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.
- .4 Test alarms and other devices.
- .5 Test water flow alarms by flowing water through inspector's test connection. When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13.
- .4 Formal Tests and Inspections:
 - .1 Do not submit request for formal test and inspection until preliminary test and corrections are completed and approved.
 - .2 Submit written request for formal inspection at least 15 days prior to inspection date.
 - .3 Repeat required tests as directed.
 - .4 Correct defects and make additional tests until systems comply with contract requirements.
 - .5 Furnish instruments, equipment, appliances, connecting devices, and personnel for tests.
 - .6 Authority of Jurisdiction or their designated representative, will witness formal tests and approve systems before they are accepted.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .3 Site Tests:
 - .1 Testing to be witnessed by authority having jurisdiction.

3.8 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 00 - Common Work Results for Fire Suppression.
- .2 Section 21 13 13 - Wet Pipe Sprinkler System
- .3 Section 26 05 00 - Common Work Results for Electrical
- .4 Section 28 31 00 - Fire Detection and Alarm

1.2 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA International).
 - .1 CSA C22.1 (latest edition), Canadian Electrical Code.
- .2 National Electrical Manufacturing Association (NEMA).
 - .1 NEMA MG-1, Motors and Generators.
- .3 National Fire Protection Association (ANSI/NFPA)
 - .1 NFPA 20-2020, Standard for the Installation of Stationary Fire Protection.
 - .2 NFPA 25-2022, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
 - .3 NFPA 110-2019, Standard for Emergency and Standby Power Systems.
 - .4 NFPA 170-2018, Standard for Fire Safety and Emergency Symbols.
- .4 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC S543, Internal Lug Quick Connect Coupling for Fire Hose.
 - .2 CAN/ULC-S1001-2011 Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems First Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for fire pump control and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Technical sheets
 - .1 Submit manufacturer's printed product literature, specifications, and data sheets for electrical fire pump and fire pump control. Technical sheets should include product characteristics, performance criterions, physical size, finish, and limitations.
- .4 Shop Drawings:
 - .1 Indicate:
 - .1 Method of anchorage
 - .2 Number of anchors.
 - .3 Supports.

- .4 Reinforcement.
- .5 Assembly details.
- .6 Accessories.
- .7 Indicate hydraulic and electrical characteristics including Net Positive Suction Head (NPSH) required, make and model number.
- .2 Provide power and control diagrams.
- .3 In addition to the foregoing documentation, submit shop drawings for the following technical data from manufacturer, including model, year, power, capacity, and dimensions for the following elements:
 - .1 Fire pump.
 - .2 Motor.
 - .3 Fire pump control panel.
 - .4 Fire pump accessories.
 - .5 Jockey pump.
 - .6 Jockey pump motor.
 - .7 Jockey pump control panel.
 - .8 Monitoring switches.
 - .9 Valves, including gate valves, check valves, and globe valves.
 - .10 Couplings
 - .11 Flow meter
 - .12 Test header for fire pumps.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance and engineering data for incorporation into manual specified in Section 01 00 10 - General Requirements and in accordance with NFPA 20.
- .2 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .3 Manufacturer's Catalogue Data:
 - .1 Manufacturer's catalogue Data, including installation instructions, specific model, type, and size for all shop drawings submitted.
- .4 Records:
 - .1 After completion, but before final acceptance, submit complete set of "As-Built" drawings of each system for record purposes.
- .5 Field Test Reports:
 - .1 Submit manufacturer's field reports specified.
 - .2 Submit contractor's Material and Test Certificate for aboveground piping and other documentation for incorporation into manual in accordance with NFPA 13.
- .6 Operation and Maintenance Manuals:
 - .1 Provide a complete original copy of NFPA 25 and incorporate it into the "Operation and Maintenance Manual".

- .2 Provide all equipment manufacturer's Owner's Operation and Maintenance Manual.
- .3 Provide maintenance data sheets including the following elements:
 - .1 Shop drawings technical data from catalogs and product literature, including the model number, type, and size.
 - .2 Relevant details concerning operation, maintenance, and servicing.
 - .3 A copy of the shop and field fire pumps test curves.
 - .4 A list of recommended spare parts.

1.5 EXTRA MATERIALS

- .1 Extra Materials:
 - .1 Furnish spare parts for each pump in accordance with Section 01 00 10 - General Requirements and as follows:
 - .1 One set of packing.
 - .2 One casing joint gasket.

1.6 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 00 10 - General Requirements
 - .1 Test reports:
 - .1 Submit certified test reports for packaged fire pumps from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Test each pump/driver package at factory to provide detailed performance data and to demonstrate compliance with NFPA and specification. Submit certified test curves for approval of Consultant.
 - .3 Test hydrostatically to meet requirements of fire protection system to which it will be connected.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.
 - .4 Manufacturer's Field Reports: manufacturer's field reports specified.
- .2 Qualifications:
 - .1 Installer: company or person specializing in packaged fire pump installations with documented experience of at least 5 years.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for recycling in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Select fire pump to satisfy fire protection system requirements and NFPA 20.
 - .2 Water supply:
 - .1 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for basis of design including NPSH available, and in accordance with NFPA 20.
 - .2 Base design on NFPA 20 and water flow rate and pressures obtained during fire hydrant flow test required in Section 21 13 13 - Wet Pipe Sprinkler Systems.
 - .2 All products used in fire safety installations shall be "CUL" or "ULC" listed and shall be labelled as such.
 - .3 Provide accessories that can withstand the normal pressure exerted in the fire protection system.

2.2 PIPES AND FITTINGS

- .1 Refer to Section 21 13 13 - Wet Pipe Sprinkler Systems.

2.3 VALVES

- .1 All valves to be listed for fire protection service.
- .2 Acceptable Products:
 - .1 Valves, NPS 2 and less, threaded ends:
 - .1 Bronze ball valve and gate valves, with outside screw and yoke (OS&Y):
 - .1 Acceptable products:
 - .1 Victaulic S/728 Firelock with monitoring switches.
 - .2 Anvil F171N.
 - .3 Jenkins Fig. 202J.
 - .4 Nibco KT-505-W-8.
 - .5 Nibco T-104-0.
 - .2 Gate valves, NPS 2½ and over, grooved or flanged ends:
 - .1 Ductile iron gate valve with outside screw and yoke (OS&Y), bronze trim, grooved or flanged ends.
 - .1 Acceptable products:
 - .1 Victaulic 771H.
 - .2 Nibco F 607 RW.
 - .3 Viking.
 - .3 Butterfly valves, NPS 2½ and over, with monitoring switch:
 - .1 Ductile iron butterfly valves, with indicating yoke, grooved ends.
 - .1 Acceptable products:
 - .1 Tyco, model BFV-N, TFP1520.

- .2 Nibco LD3510 8.
- .3 Victaulic.
- .4 Swing check valves with composite material disc:
 - .1 Flanged ends:
 - .1 Acceptable products:
 - .1 Nibco F908W.
 - .2 Viking D-1 and G-1 flanged.
 - .3 Rite, model 212.

2.4 FIRE PUMP UNIT (P-F-1)

- .1 General:
 - .1 ULC listed vertical in line fire pump, including all required accessories and control devices for proper operation of the fire pump.
 - .2 Pump unit, controller, and accessories mounted on a skid and wired at workshop.
 - .3 Accessories in accordance with NFPA 20 Standard, including the following (P-F-1):
 - .1 90 mm (3.54 in) pressure gauges on suction and discharge sides equipped with NPS ½ control valve.
 - .2 OS&Y valves on suction sides, electrically supervised.
 - .3 Butterfly valves on discharge sides, electrically supervised.
- .2 Compact fire pump unit including:
 - .1 Fire pump.
 - .2 Electrical drive motor.
 - .3 Excess pressure pump with control panel (P-F-2).
 - .4 All accessories installed at manufacturer's shop.
 - .5 Test header with flow meter discharging into local funnel floor drain for pump tests.
 - .6 Test header with discharge outlet for fire pump tests and flow meter calibration.
 - .7 Required isolation valves.
 - .8 All integrated controls.
- .3 Acceptable Products, Vertical in-line fire pump unit (P-F-1):
 - .1 Armstrong, FirePack jockey pump Series.
 - .2 AC Fire Pump.

2.5 FIRE PUMP (P-F-1)

- .1 General
 - .1 Cast iron body with bronze impeller, steel driving shaft with bronze coupling and mechanical gasket with stainless-steel parts.
 - .2 Pump rated for an 860 kPa suction pressure.
 - .3 Pump mounted on a steel pedestal.

- .4 Nominal flow capacity to satisfy fire protection system requirement and NFPA 20. Pump capable of producing 150% of rated flow at 65% of rated pressure.
- .5 Pump shall be capable of producing 140% of rated pressure at no flow condition.
- .2 Pump Characteristics:
 - .1 Pump type: Vertical in line.
 - .2 Capacity: to satisfy fire protection requirements and NFPA :
 - .1 Refer to drawing schedule for preliminary requirements.
 - .2 Contractor and contractor's Fire Protection Engineer to confirm flow, pressure, and NPSH requirements after completing fire hydrant flow test required in Section 21 13 13 - Wet Pipe Sprinkler Systems.
 - .3 Pump Rated Pressure: 100 psi.
 - .4 Minimal suction pressure: 40 psi, confirm after completing fire hydrant flow test required in Section 21 13 13 - Wet Pipe Sprinkler Systems.
 - .5 Maximal suction pressure: 50 psi, confirm after completing fire hydrant flow test required in Section 21 13 13 - Wet Pipe Sprinkler Systems.
 - .6 Power: 30 to 50 HP, confirm after completing fire hydrant flow test required in Section 21 13 13 - Wet Pipe Sprinkler Systems.
 - .7 Rotation speed: 1800 rpm or 3550 rpm.
 - .8 Acceptable products:
 - .1 Armstrong, VIL 5x5x8FM.
 - .2 AC Fire Pump
 - .3 Aurora.
 - .4 Replacement materials or products: Approved by addendum according

2.6 CONTROL PANEL (P-F-1)

- .1 Control panel with integrated automatic transfer switch in accordance with NFPA 20 and ULC listed, with the following characteristics:
 - .1 Manual/automatic type with an automatic power transfer switch.
 - .2 Starting type: Autotransformer reduced voltage starter.
 - .3 Single type.
 - .4 Equipped with terminals for regular and emergency electrical supply.
 - .5 Completely prewired and tested in shop, mounted in a NEMA 2 cabinet.
 - .6 600 VAC, 60, Hz, three (3) phases.
 - .7 Circuit breakers with fuses of adequate capacity on each phase.
 - .8 Pressure switch.
 - .9 Starter controlled by pressure switch and external lever.
 - .10 Load control timer, for a period not exceeding seven (7) minutes.
 - .11 Pilot lamps indicating electrical supply and phase reversal.
 - .12 Contacts for proof of operation and low suction pressure.
 - .13 Two (2) position operation selector (automatic and manual).
- .2 Acceptable Products:

- .1 Tornatech, model GPR+GPU
- .2 Cutler-Hammer.
- .3 Eaton.

2.7 DRIVER

- .1 General:
 - .1 Electric horizontal drip proof motor UL and CSA listed for fire pump service, in accordance with NEMA MG-1 and NEMA B, with a service factor of 1.15, complete with storage batteries, starting equipment, and controls.
 - .2 Driver characteristics:
 - .1 Electric motor including all accessories required for proper operation:
 - .1 Power: 30 to 50 HP at 575/3/60.
 - .2 Rotation speed: 1880 or 3550 rpm.

2.8 PRESSURE MAINTENANCE (JOCKEY) PUMP (P-F-2)

- .1 General: Horizontal, multi-stage, close coupled, electrically driven pump, and controller.
- .2 Characteristics:
 - .1 Flow rate: refer to drawing schedule
 - .2 Pressure: 110 psi
 - .3 Motor: between 0.75 and 1.5 HP at 575/3/60.
 - .4 Acceptable products:
 - .1 Armstrong, Series 4700, model VMS-01:08B-2P
 - .2 AC Fire Pump, Series e-SV
- .3 Pressure Maintenance Pump Controller:
 - .1 Automatic controller, full-voltage starter, pre-wired in manufacturer's shop.
 - .2 Pressure switch.
 - .3 Pilot lamps for pump running, electrical supply, and overload.
 - .4 Disconnect switch with external control.
 - .5 Acceptable products:
 - .1 Tornatech, model JP3.
 - .2 Cutler-Hammer.
 - .3 Eaton.
- .4 Operation
 - .1 Jockey pump starts on a drop in system pressure. It remains in operation for a minimum predetermined period. If the system pressure continues to drop, the fire pump is activated.

2.9 FIRE PUMP TEST HEADER

- .1 Multiple type connection, installed as indicated, for built-in mounting with indicating plates, polished finish, with embedded inscription directly on the plates, quick connect caps with metal chains.

- .2 Test Valve: 63-mm angle valve for fire pump test header connection, cast or forged brass complete with hand wheel, with quick connect corresponding to local Fire service.

2.10 FLOW METER

- .1 ULC and FM Listed Venturi type flow meter for fire pump testing, with 150-mm pressure gauge, from the same manufacturer as the fire pumps.

2.11 HANGERS & SUPPORTS

- .1 Hangers for fire protection service, in compliance with NFPA 13 Standard, as well as Sections 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

2.12 SUPERVISORY SWITCHES

- .1 General: Switches approved for fire protection service, complying with NFPA 13 Standard.
- .2 Valves:
 - .1 Mechanically attached to valve body, with normally open (N.O.) and normally closed (N.C.) contacts, with monitoring capability.
 - .2 Add monitoring contacts on non-supervised valves, as indicated on-site.

2.13 PRESSURE GAUGES

- .1 ULC approved pressure gauges in compliance with Section 23 05 19.13 - Thermometers and Pressure Gauges.
- .2 Maximum limit of not less than twice normal working pressure at point where installed.
- .3 Provide an isolating bronze 3-way valve, with drainage fitting at every gauge.

2.14 IDENTIFICATION

- .1 Nameplate for the fire pump and pump motor: According to NFPA 20 and Section 2305 53 - Identification for HVAC Piping and Equipment.
- .2 Fire pump test header identification:
 - .1 Identification plate for fire pump test header shall indicate that it serves the fire pumps of the building.
- .3 Fire protection equipment identification according to NFPA 170.

Part 3 Execution

3.1 GENERAL

- .1 Install, verify, and submit to an acceptance test the fire pump unit in accordance with NFPA 20 Standard.
- .2 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install in accordance with established Standards and the requirements of laws, regulations, Standards, codes in force and according to the manufacturer's instructions.

- .2 Install pipe work in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework, supplemented as specified herein.
- .3 Proper operation and installation coordination of the system, including automatic sprinkler systems, system supervision, and start-up, are all under the responsibility of the Fire Protection Contractor.
- .4 Clearly mark drain valves, main control valves, and auxiliary valves.
- .5 Install pump test piping.
- .6 Provide one valve per fire pump test header outlets. Store them inside a cabinet for this purpose and inside the pump room once commissioning is completed.

3.3 TRAINING

- .1 Organize a 4-hour training session for operational and maintenance (O&M) personnel.
- .2 Training will cover Standard operation, emergency operations and maintenance of system, as per NFPA 25 Standard.

3.4 TESTS & VERIFICATIONS

- .1 Carry out the following tests on the fire pump installation, in accordance with NFPA 20 Standard:
 - .1 Execute tests in manufacturers shop (shop curves) in order to provide detailed data on pump performance.
 - .2 Execute flushing in accordance with NFPA 20.
 - .3 Execute complete hydrostatic testing on the automatic sprinkler systems piping and appurtenances at a pressure of 1,380 kPa for two (2) hours.
 - .4 Execute a fire pump flow test at 0%, 100%, and 150% of rated flow. Make sure no components overheat.
 - .5 Execute a load start test of the fire pump and bring up to rated speed without interruption under the conditions of a discharge equal to peak load.
 - .6 Execute a phase reversal test on normal power supply and on the alternate power supply.
 - .7 Execute a minimum of six (6) manual and automatic tests of the fire pump control panel in accordance with manufacturer's instructions. Each test should last at least five (5) minutes.
 - .8 Simulate loss of normal power supply. Check that the transfer to the emergency power supply is carried out when the pump operates at peak load.
 - .9 Simulate all fire pump alarms conditions and check that all alarm conditions are relayed to the fire panel.
 - .10 Operate fire pump for a minimum period of one (1) hour.
 - .11 Execute opening and closing of all water supply control valves while under system pressure.
- .2 Conduct tests in presence of the Authority Having Jurisdiction and the Consultant or their designated alternate and supply test certificates, as required by NFPA 20 Standard.
- .3 Provide and perform all tests with calibrated equipment. Equipment calibrations shall have been done inside within one (1) year prior to the test period.

3.5 REPORT & CERTIFICATE

- .1 Provide both inspection report and inspection attestation, as per NFPA 20, to the Departmental Representative at the end of the project in addition to the properly completed and signed Contractor materials and tests certificate. Record all test results in a notebook appended to the report.
- .2 Develop, with Contractor's Fire Protection Engineer's assistance, detailed instructions for O & M installation.

3.6 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 01 79 00.13 - Demonstration and Training for Building Commissioning
- .3 Section 01 91 13.13 - Commissioning Plan
- .4 Section 01 91 13.16 - Commissioning Forms
- .5 Section 01 91 14 - Facility Commissioning Mechanical
- .6 Section 01 91 15 - Facility Commissioning Electrical
- .7 Section 09 91 00 - Painting
- .8 Section 23 05 00 - Common Work Results for HVAC
- .9 Section 23 05 01 - Use of HVAC Systems During Construction
- .10 Section 23 05 02 - Pipework Testing
- .11 Section 23 05 03 - Mechanical Start-Up
- .12 Section 23 05 13 - Common Motor Requirements for HVAC Equipment
- .13 Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .14 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .15 Section 23 05 48 - Vibration and Seismic Controls for HVAC
- .16 Section 23 05 53 - Identification for HVAC Piping and Equipment
- .17 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC
- .18 Section 23 08 16 - Cleaning and Start-up of HVAC Piping Systems
- .19 Section 25 05 01 - EMCS: General Requirements

1.2 ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

- .1 For additional acronyms, abbreviations, and definitions used in these specifications, refer to:
 - .1 Section 23 05 00 - Common Work Results for Mechanical
 - .2 Section 25 05 01 - EMCS: General Requirements
 - .3 Section 26 05 00 Common Work Results for Electrical
- .2 The following is a list of acronyms and abbreviations used in these specifications.

DW	Domestic Water
DCW	Domestic Cold Water
DHW	Domestic Hot Water
DHWR	Domestic Hot Water Recirculation
NPCW	Non-potable cold water, trap seal primer lines
SAN	Sanitary waste
V	Sanitary vent
STW	Storm water drain (rain water leader)
RO	Reverse Osmosis water
RDN	Radon

1.3 REFERENCE STANDARDS

- .1 National Plumbing Code of Canada (NPCC 2020)

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for all plumbing equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .2 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .3 In addition to transmittal letter referred to in Section 01 00 10 - General Requirements: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for all plumbing equipment for incorporation into manual.
 - .1 Provide 1 complete sets of hard copy and 1 soft copy Operation and Maintenance manual prior to system or equipment tests.
 - .2 Operation and Maintenance manual to be approved by Consultant and Owner, and 4 final hard copies and 1 soft copy deposited with Owner before final inspection.

- .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
- .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
 - .1 Submit PDF copies of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed by Consultant.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
 - .1 Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.

- .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows:

AS BUILT DRAWINGS: THIS DRAWING
HAS BEEN REVISED TO SHOW
MECHANICAL SYSTEMS AS INSTALLED

(Signature of Contractor) (Date)
- .3 Submit to Consultant for approval and make corrections as directed.
- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Furnish spare parts as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One glass for each gauge glass.
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of packaging materials padding, pallets, and crates, as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

1.8 PLUMBING COST BREAKDOWN

- .1 Provide detailed breakdown of Plumbing Sub-Contractor's work prior to first progress claim. Breakdown to be itemized with separate labour and material listing against each item of the contract breakdown. After approval by Consultant cost breakdown will be used as basis for progress payment.
- .2 Breakdown and subsequent Progress Claims are to be itemized with separate labour and material listing against each item of the contract breakdown where indicated as required.
- .3 Progress claims will not be reviewed if they do not breakout materials and labour where appropriate.
- .4 Plumbing Contract Breakdown:
 - .1 General
 - .1 Mobilization / Demobilization
 - .2 Administration & Safety
 - .3 Shop drawings
 - .2 Domestic Water Systems & Equipment
 - .1 Water service entry (up to booster pump package)
 - .2 Water pressure booster pump package
 - .3 Hot water heaters, expansion tanks, hot water recirculation pumps
 - .4 Piping, fittings, and valves
 - .5 Insulation
 - .3 Reverse Osmosis System & Equipment
 - .1 RO production unit
 - .2 Piping, fittings, and valves
 - .3 Insulation
 - .4 Sanitary (DVW) systems
 - .1 Piping - below slab
 - .2 Piping - above slab
 - .3 Insulation
 - .5 Plumbing Fixtures
 - .1 Fixture rough-ins
 - .2 Fixture installation
 - .6 Storm water drainage systems
 - .1 Piping - below slab
 - .2 Piping - above slab
 - .3 Insulation
 - .7 Radon mitigation systems
 - .1 Radon collection pits
 - .2 Piping - below slab
 - .3 Piping - above slab

- .8 Documentation & Closeout
 - .1 Seismic Restraints
 - .2 Testing and Balancing
 - .3 Performance Verification
 - .4 Commissioning
 - .5 Operation & Maintenance Manuals
 - .6 As-built drawings
 - .7 Training
 - .8 Warranty Review
- .5 Mechanical Controls Contract Breakdown
 - .1 Refer to Section 25 05 01 - EMCS: General Requirements

Part 2 Products - Not Used

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for acceptable installation in accordance with manufacturer's written instructions.
 - .1 Inform the General Contractor of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation only after unacceptable conditions have been remedied and directed to do so by the General Contractor.

3.2 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 00 - Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 DEMONSTRATION & TRAINING

- .1 Consultant will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections as supplemented with minimum training requirements as follows:
 - .1 Division 21 items: refer to Section 21 05 00 - Common Work Results for Fire Suppression
 - .2 Division 23 items: refer to Section 23 05 00 - Common Work Results for Mechanical

- .3 Division 25 items: refer to Section 25 01 12 - EMCS: Training
- .4 Backflow preventers: 2 hours
- .5 Trap seal primers and trap guards: 30 minutes
- .6 Mixing valves: 30 minutes
- .7 Expansion tanks: 15 minutes
- .8 Emergency showers, eyewash stations, and emergency fixture mixing valves: 30 minutes
- .9 Condensate neutralizer and Acid neutralizing tanks: 15 minutes
- .10 Reverse Osmosis system: 1 hour
- .11 Plumbing pumps: refer to Section 22 10 10 - Plumbing Pumps
- .12 Domestic hot water heaters: 30 minutes
- .13 Plumbing fixtures (excluded those listed above): 1 hour

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 22 05 00 - Common Work Results for Plumbing.
- .3 Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM A126-04 (2009), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - .2 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .2 CSA Group (CSA)
 - .1 CSA-B64 Series-21, Backflow Preventers and Vacuum Breakers.
 - .2 CSA B79.2-22, Cleanouts.
 - .3 CAN/CSA-B356-22, Water Pressure Reducing Valves for Domestic Water Supply Systems.
- .3 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP).
 - .1 IPMVP 2007 Version.
- .4 National Research Council Canada (NRC)
 - .1 National Plumbing Code of Canada 2020 (NPC).
- .5 Plumbing and Drainage Institute (PDI)
 - .1 PDI-G101-R2010, Testing and Rating Procedure for Grease Interceptors with Appendix of Installation and Maintenance.
 - .2 PDI-WH201-R2010, Water Hammer Arresters Standard.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for all plumbing products and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings to indicate number of anchors, dimensions finishes, accessories, materials, construction and assembly details, and method of anchorage.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements

- .2 Operation and Maintenance Data: submit operation and maintenance data for plumbing specialties and accessories for incorporation into manual.
 - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect plumbing materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of packaging materials padding, pallets, and crates, as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 LEAD CONTENT

- .1 All plumbing specialties and accessories are to be lead free type where contact will occur with potable water. Low lead type will only be acceptable where it has been demonstrated that lead free items are not available.

2.2 FLOOR DRAINS

- .1 Floor Drains and Trench Drains: to CSA B79.
- .2 Type FD-1: general duty ; cast iron body round, adjustable head, sediment basket nickel bronze strainer, integral seepage pan, and clamping collar.
 - .1 For use in public areas.
 - .2 Acceptable material: Watts FD-100NH-C-A series, Zurn
- .3 Type FD-2: general duty; cast iron body round, adjustable head, sediment basket nickel bronze strainer, integral seepage pan, and clamping collar.
 - .1 For use in service areas / non-public areas.
 - .2 Acceptable material: Watts FD-100NH-C-A series, Watts
- .4 Type FD-3: combination funnel floor drain ; cast iron body with integral seepage pan, clamping collar, nickel-bronze adjustable head strainer with integral funnel.
 - .1 For use in service areas / non-public areas.

- .2 Acceptable material: Watts FD-100NH-C-EG series, Zurn

2.3 ROOF DRAINS

- .1 Type 1: epoxy coated cast iron body, flashing clamp ring with integral gravel stop, under deck clamp and deck flange / adjustable extension to suit roof construction, rough bronze dome.
 - .1 Acceptable material: Watts RD-100 series with -D-F-k81 options, Zurn

2.4 CLEANOUTS

- .1 PVC-DWV stack cleanout with neoprene gasket, line size.
- .2 Access Covers:
 - .1 Wall Access: face or wall type, round polished nickel bronze cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.
 - .1 Acceptable material: Smith Fig 4720-U, Zurn, Watts
 - .2 Floor Access:
 - .1 Heavy traffic areas: heavy duty duct coated cast iron, removable positive gasket seal closure plug, 150mm round adjustable scoriated cast iron cover, CO cast in cover, adjustable collar, flashing clamp.
 - .1 Acceptable Material: Smith 4220S-FC, Zurn, Watts.
 - .2 Carpet and linoleum floor finishes: heavy cast iron epoxy coated, MJ, brass screws, round cover, adjustable collar, tile recess cover for inlay of finished flooring, nickel bronze finish, bronze plug with gasket seal.
 - .1 Acceptable material: Smith Fig 4141S, Zurn, Watts.
 - .3 Tile floor finishes: heavy cast iron epoxy coated, MJ, brass screws, square nickel bronze top, adjustable collar, nickel bronze finish, bronze plug with gasket seal.
 - .1 Acceptable material: Smith Fig 4041S, Zurn, Watts.

2.5 HOSE BIBBS

- .1 Type HB-1: interior hose bibb
 - .1 CSA approved, bent nose with flange, 19 diam., chrome plated brass construction complete with integral vacuum breaker, hose thread spout, replaceable composition disc.
 - .1 Acceptable material: Acorn 8121CP, Watts.
- .2 Type NFHB: Non-Freeze Hose Bibb
 - .1 Recessed type with integral vacuum breaker, NPS 3/4 hose outlet, removable operating key. Polished bronze finish, wall clamp, length to suit wall thickness.
 - .1 Acceptable materials: Watts HY-725-88, Acorn

2.6 WATER HAMMER ARRESTORS

- .1 Stainless steel or Copper construction, piston type: to PDI-WH201.
- .2 Size: according to manufacturer's recommendations and as indicated.
- .3 Acceptable material: Watts, Zurn, Oatey

2.7 BACK FLOW PREVENTERS

- .1 General Duty: Reduced Pressure Backflow Preventer
 - .1 Approvals: CSA B64.4
 - .2 Construction: Bronze body and covers, reduced pressure principal, dual mechanical stainless steel spring loaded poppet check valves, hydraulically dependent differential pressure relief valve, cast brass body, four test ports, dual full port ball shutoff valves.
 - .3 Max working pressure: 1205 kPa.
 - .4 Temperature range: 0.5°C to 82°C
 - .5 Size: line size.
 - .6 Configuration: straight pattern.
 - .7 Application: general backflow prevention.
 - .8 Acceptable Material: Watts LF009, Zurn
- .2 Water Service Entry: Reduced Pressure Backflow Preventer
 - .1 Approvals: ULC and FM approved and to CSA B64.4
 - .2 Construction: Reduced pressure principle backflow preventer, dual resilient seated spring loaded poppet type check valved, hydraulically dependent differential pressure relief valve, top entry design, replaceable EPDM discs, FDA epoxy coated ductile iron body and steel cover, SS springs and fasteners, bronze seats, full port ball valve test cocks, line size OS&Y isolation valves upstream and downstream of assembly.
 - .3 Max working pressure: 1205 kPa.
 - .4 Temperature range: 0.5°C to 60°C
 - .5 Size: line size.
 - .6 Configuration: straight pattern.
 - .7 Application: general backflow prevention.
 - .8 Acceptable Material: Watts LF009, Zurn
- .3 Fire Protection System: refer to Section 21 13 13 - Wet Pipe Sprinkler Systems

2.8 PRESSURE REGULATORS

- .1 Capacity: as indicated.
 - .1 Inlet pressure: 1034 kPa.
 - .2 Outlet pressure: 413 kPa.
- .2 Up to NPS 1-1/2 bronze bodies, screwed: to ASTM B62.
- .3 NPS 2 and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class B.
 - .1 Epoxy coated where used on potable water.
- .4 Semi-steel spring chambers with bronze trim.
- .5 Acceptable Material: Watts, Zurn

2.9 WATER MAKE-UP ASSEMBLY

- .1 Complete with backflow preventer pressure gauge on inlet and outlet, pressure reducing valve to CAN/CSA-B356, pressure relief valve on low pressure side and gate valves on inlet and outlet.
- .2 Acceptable material: Watts, Zurn

2.10 WATER METERS

- .1 Type and construction to the requirements of the City of Whitehorse.
- .2 Displacement type to ANSI/AWWA C700, Cast bronze, Magnetic drive, hermetically sealed register.
- .3 Capacity: as indicated.
- .4 Accessories: remote readout device.
- .5 Size: one size smaller than line size.

2.11 TRAP SEAL PRIMERS

- .1 Pressure drop activated trap seal primer
 - .1 Brass, with integral vacuum breaker, NPS 1/2 solder ends, NPS 1/2 drip line connection, inline designed to deliver metered water when any fixture is opened in building.
 - .2 Optional dual drain primer assembly.
 - .3 Acceptable material: PPP Inc. Model PR-500 with optional Distribution Unit as required.
- .2 Electronic trap seal primer
 - .1 Factory assembled, tested, and pre-piped electric trap priming manifold, complete with atmospheric vacuum breaker, WOG rated ball valve, pre-set 24hr clock, manual override switch, 120V solenoid valve, 120V, 1 phase, 60 Hz, 3 wire single point power connection, minimum 5 amp breaker, 5 second dwell function, 19mm water distribution, 12mm outlet compression fittings complete with balancing valves, 19mm water hammer arrestor, 16 gauge surface mounted cabinet with access door, sized to match the number of traps, equally primes each trap, CSA approved, lifetime warranty.
 - .2 Standard of Acceptance: PPP Prime-time Electronic Trap Priming Manifold model PT.

2.12 TRAP GUARDS

- .1 Material: smooth, soft, flexible, elastomeric PVC material molded into shape of duck's bill, open on top with curl closure at bottom.
- .2 Operation: allows wastewater to open and adequately discharge floor drain through its interior and closes and returns to original molded shape after wastewater discharge is complete.
- .3 Compliance: NSK/ANSI 14, CSA B79.
- .4 Acceptable material: ProSet Systems Trap Guard.

2.13 MIXING VALVES

- .1 General Duty Fixture Mixing Valves:
 - .1 Certifications: to ASSE Standard 1017 and anti scald requirements of ASSE standard 1016
 - .2 Construction: Single fixture thermostatic controller, brass and bronze body, removable brass and stainless steel flow control components, 360deg handle adjustment, vandal resistant lockable handle, 10dia compression inlet and outlets for single fixture use, rough bronze finish, check stops.
 - .1 Mixing valve for showers to be provided in a cabinet c/w shut-off valves, unions and with thermometer on mixed outlet.
 - .3 Capacity:
 - .1 Single fixture: to 7.58 L/min at 69 kPa.
 - .2 Grouped fixtures: to 34 L/min at 69 kPa.
 - .4 Temperature range: 30°C to 71°C.
 - .5 Maximum working pressure: 861 kPa.
 - .6 Acceptable Material:
 - .1 Grouped fixtures: Symmons Thermixer model 5-130-CK, 19mm screwed connection, Leonard.

2.14 VENT FLASHING

- .1 CSA approved stainless steel flashing sleeve with integral deck flange, premoulded urethane insulation liner, EPDM Triple Pressure Grommet Seal and EPDM Base Seal.
- .2 Acceptable material:
 - .1 Flat roof: Thaler SJ-37.
 - .2 Sloped roof: Thaler SJ-44.

2.15 DIAPHRAGM TYPE EXPANSION TANKS

- .1 Domestic Hot Water Expansion Tanks
 - .1 General: cylindrical steel pressurized diaphragm type expansion tank.
 - .2 Diaphragm: sealed butyl suitable for potable water.
 - .3 Working pressure: 1035 kPa.
 - .4 Air Pre-charge: 276 kPa.
 - .5 Acceptable material: Amtrol Therm-X-Trol.
 - .6 Schedule: refer to drawing schedules.
- .2 Domestic Cold Water Pressure Tanks
 - .1 General: cylindrical steel, urethane finish, pressurized butyl diaphragm type expansion tank.
 - .2 Diaphragm: sealed butyl suitable for potable water.
 - .3 Working Pressure: 1035 kPa.
 - .4 Air Pre-charge: 276 kPa.
 - .5 Acceptable material: Amtrol Well-X-Trol.

- .6 Schedule: refer to drawing schedules.

2.16 AIR ADMITTANCE VALVE (AAV)

- .1 General: Positive closure at zero differential pressure and under positive internal pressures, PVC body, silicone membrane, screen on air inlets to guard seal.
- .2 Screwed or solvent cement fittings.
- .3 Approvals: NSF 14, ASSE 1050 and 1051
- .4 Acceptable material: Oatey Sure-Vent

2.17 EYEWASH STATIONS

- .1 Emergency Eyewash Station
 - .1 Wall mounted swing-down eyewash with no bowl (mounted over had washing sink) with auto-flow on swing down. Arm to be polished chrome plated brass. Spray heads to be polypropylene plastic construction and include integrated nylon flip-top covers, 1.6 GPM flow control and 60 PPI polyurethane filter. Supply connection to be 13mm.
 - .2 Standard of Acceptance: Guardian G1848
- .2 Emergency Eyewash Mixing Valve
 - .1 All brass and stainless steel design, with liquid filled motor, check stops, safety shut-off should cold water supply fail, hot water failure will by-pass to cold water, volume control valve, rough bronze, ball valves, outlet temperature gauge, 25mm hot/cold inlets, 13mm tempered outlet. Tempered water factory set at 26°C. Flow range of 3.0 to 13 GPM with a maximum pressure drop of 30 PSI. Unit shall be certified to ASSE 1071.
 - .2 Standard of Acceptance: Guardian G6020.

2.18 EMERGENCY SHOWER / EYEWASH

- .1 Emergency Drench Shower / Eyewash Station
 - .1 Combination shower and eye/face wash with stainless steel 279 mm round bowl, eye/face wash head with inverted directional laminar flow for zero vertical velocity supplied by an integral flow control, hydrodynamic designed ABS plastic showerhead with flow control, chrome-plated brass stay-open ball valve equipped with stainless steel ball and stem, chrome-plated brass in-line 50 x 50 mesh water strainer, schedule 40 hot-dipped galvanized steel pipe and fittings, powder-coated cast-iron 229mm diameter floor flange, self-adhesive high visibility safety green and bright yellow stripes, universal sign, and 35Ø IPS supply.
 - .2 All exposed piping to unit to be chrome plated. 32mmØ inlet and outlet connections.
 - .3 Drench shower requires minimum 76 L/min (20gpm) flow for 15 minutes.
 - .4 Acceptable Material: Guardian G1950P, Haws 8300-8309.
- .2 Emergency Shower Mixing Valve
 - .1 Thermostatic temperature control valve: all brass and stainless steel design, with liquid filled motor, check stops, safety shut-off should cold water supply fail, hot water failure will by-pass to cold water, volume control valve, rough bronze, ball

valves, outlet temperature gauge, housed in a surface mounted 23" x 19" x 6-3/4" (584mm x 483mm x 171mm) stainless steel cabinet, 1-1/4" (32mm) top supplies, top outlet, with unions. Tempered water factory set at 80°F (26°C).

- .2 Standard of Acceptance: Guardian G3800LF, Haws 9201-9205SUR

2.19 CONDENSATE NEUTRALIZER

- .1 General: Manufactured high-capacity condensate neutralizer and media for condensing heating appliances.
- .2 Capacity: 170 L/hr of condensate
- .3 Tank:
- .1 Material: polypropylene body and lid
- .2 Low profile 18 L with baffles designed to channel flow through neutralizing media for complete neutralization.
- .3 Integral bypass feature prevents condensate backflow into the appliance.
- .4 Dimensions: 445mm X 343mm X 203mm (L xW x H)
- .5 Inlet connections: 1" NPT with unions, located 165mm above bottom to centerline
- .6 Outlet connections: 1" NPT with unions, located 165mm above bottom to centerline
- .4 Neutralizing media:
- .1 Blended neutralizing media intended to neutralize the pH of acidic condensate fluids to a more neutral level prior to discharge into building sanitary system.
- .2 Materials: calcium carbonate (limestone) and magnesium oxide
- .5 Acceptable material: Axiom Industries NT25 with 18 kg charge of LipHter Media

2.20 NEUTRALIZING TANK

- .1 General: Round, seamless high density polyethylene tank, 38mm MJ connections, gasketed 12mm thick poly cover with stainless steel bolts, tank cover with inspection port, for on grade installations.
- .2 Initial charge of limestone chips of 50mmØ limestone with calcium carbonate equivalent in excess of 90%.
- .3 Maintenance instructions sign: provide for installation at tank.
- .4 Capacity: 22L tank empty, 9 L including limestone charge
- .5 Acceptable material: Watts Orion T5, SMS AN 4/SI-MD

2.21 REVERSE OSMOSIS SYSTEM

- .1 Packaged reverse osmosis system consisting of a steel frame, inlet solenoid valve, pre-filter housing for 4.5"x20" filters, high pressure booster pump, high pressure membrane housings with extra low energy reverse osmosis membranes, rotameter flow meters, pressure gauges, and controller.
- .2 Membranes shall be 4Ø" x 40" long and be polyamide thin-film composite. Maximum operating temperature 45°C, operating pressure 600 PSI, and pressure drop of 15 PSI. Able to operate in a continuous pH range of 2-11 with a maximum silt density index of 5 and chlorine tolerance of <0.1ppm. Membranes shall be housed in a stainless steel housing.

- .3 Controller will include audible and visual alarms, a TDS monitor with 0-999 ppm sensor range and 2 line 20 character LED backlite display. Controller to include selectable flush types and switch inputs and TDS calibration and setpoint adjustment. Controller input/outputs shall be switched typed and include: low pressure, RO storage tank full and low, and pre-treatment lockout. Controller shall also include relays for inlet and flush solenoid valves and for the RO pressure boosting pump.
- .4 Flow rate to be 8.8 GPM with a daily rate of 9,500 gallons.
- .5 Power for system to be 208V/1Ø/6-Hz.
- .6 Standard of Acceptance: Excalibur Water Systems Surflo RO-SFC8

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 INSTALLATION

- .1 Install in accordance with National Plumbing Code of Canada (NPC).
- .2 Install in accordance with manufacturer's instructions and as specified.

3.3 CLEANOUTS

- .1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

3.4 NON-FREEZE WALL HYDRANTS

- .1 Install 600 mm above finished grade and as indicated.

3.5 WATER HAMMER ARRESTORS

- .1 Install on branch supplies to fixtures or group of fixtures where indicated.
- .2 Locate in an upright position between the last two fixtures on a line, or horizontally at the end of line closest to supply source.
- .3 Size: to manufacturers recommendations and as indicated.

3.6 BACK FLOW PREVENTERS

- .1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code.
- .2 Pipe discharge to terminate over nearest drain or service sink.
- .3 Provide adequate space all around valves to enable annual testing and service.
- .4 Test to requirements of CSA-B64 Series
 - .1 All tests to be witnessed by Authority Having Jurisdiction and the Consultant or their designated representative.
 - .2 Provide copies of all test certificates in O&M manual.

3.7 TRAP GUARDS

- .1 Provide for all floor drains except within laboratory spaces.

3.8 TRAP SEAL PRIMERS

- .1 Install for floor drains within the laboratory area.
- .2 Electronic trap seal primers to be provided unless explicitly noted otherwise.
- .3 Pressure drop activated trap seal primers are not to be used without written approval of Consultant.
 - .1 Where approved for use, install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of Consultant, or provide direct connection to DCW piping with ball valve isolation.
- .4 Install soft copper or PEX tubing to floor drain.

3.9 WATER METERS

- .1 Install water metre provided by local water authority.
- .2 Install water metre as indicated.

3.10 MIXING STATIONS

- .1 Install as noted on plans, specifications and in details

3.11 EXPANSION TANKS

- .1 Install as noted on plans, specifications and in details and as per manufacturer's written instructions.

3.12 AIR ADMITTANCE VALVE (AAV)

- .1 Install in the upright position to the requirements of the manufacturer.
- .2 AAV's to be used only on fixtures identified on drawings.

3.13 PLUMBING VENT

- .1 Coordinate with roof flashings and install as per manufacturers recommendations.

3.14 CONDENSATE NEUTRALIZER

- .1 Allow 900mm clearance above neutralizer for removal of top cover and addition of neutralizing media.
- .2 Install where identified in the Plumbing Fixture Schedule or where indicated on the mechanical drawings.

3.15 ACID NEUTRALIZER

- .1 Allow 368mm clearance above neutralizer for removal of top cover and addition of neutralizing media.
- .2 Install below sinks where identified in the Plumbing Fixture Schedule or where indicated on the mechanical drawings.

3.16 START-UP

- .1 General:
 - .1 In accordance with the following sections and supplemented as specified herein.
 - .1 Section 01 91 13 - General Commissioning Requirements: General Requirements,
 - .2 Section 23 08 13 - Performance Verification of HVAC Systems
 - .3 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems
 - .2 Timing: start-up only after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Certificate of static completion has been issued.
 - .3 Provide continuous supervision during start-up.

3.17 TESTING AND ADJUSTING

- .1 General:
 - .1 Test and adjust plumbing specialties and accessories in accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified.
- .2 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After certificate of completion has been issued by authority having jurisdiction.
- .3 Application tolerances:
 - .1 Pressure at fixtures: +/- 70 kPa.
 - .2 Flow rate at fixtures: +/- 20%.
- .4 Adjustments:
 - .1 Verify that flow rate and pressure meet design criteria.
 - .2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.
- .5 Floor drains:
 - .1 Verify operation of trap seal primer.
 - .2 Prime, using trap primer. Adjust flow rate to suit site conditions.
 - .3 Check operations of flushing features.
 - .4 Check security, accessibility, removability of strainer.
 - .5 Clean out baskets.
- .6 Vacuum breakers, backflow preventers, backwater valves:
 - .1 Test tightness, accessibility for O&M of cover and of valve.
 - .2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.
 - .3 Verify visibility of discharge from open ports.
- .7 Roof drains:

- .1 Check location at low points in roof.
- .2 Check security, removability of dome.
- .3 Clean out sumps.
- .4 Verify provisions for movement of roof systems.
- .8 Access doors:
 - .1 Verify size and location relative to items to be accessed.
- .9 Cleanouts:
 - .1 Verify covers are gas-tight, secure, yet readily removable.
- .10 Water hammer arrestors:
 - .1 Verify proper installation of correct type of water hammer arrester.
- .11 Wall, ground hydrants:
 - .1 Verify complete drainage, freeze protection.
 - .2 Verify operation of vacuum breakers.
- .12 Pressure regulators, PRV assemblies:
 - .1 Adjust settings to suit locations, flow rates, pressure conditions.
- .13 Acid neutralizers:
 - .1 Fill with neutralizing media, using manufacturer's recommended procedures and materials.
- .14 Hose bibbs, sediment faucets:
 - .1 Verify that flow and pressure meet design criteria.
 - .2 Check for leaks, replace compression washer if required.
- .15 Hydronic system water Make-up Assembly:
 - .1 Verify flow, pressure, and connection.
- .16 Water meters:
 - .1 Verify location and accessibility.
 - .2 Test metre reading accuracy.

3.18 CLOSEOUT ACTIVITIES

- .1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning Requirements: reports, supplemented as specified.
- .2 Training: provide training in accordance with Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel, supplemented as specified.

3.19 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse in accordance with Section 01 00 10 - General Requirements

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.20 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by plumbing specialties and accessories installation.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 15 - Common Installation Requirements for HVAC Pipework
- .3 Section 23 05 23.01 - Valves - Bronze
- .4 Section 23 05 23.02 - Valves - Cast Iron
- .5 Section 23 05 23.03 - Valves - Cast Steel
- .6 Section 23 05 23.05 - Valves - Butterfly

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1-1983 (R2006), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International (ASTM)
 - .1 ASTM A276-08, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-08a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-08a, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2008, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit data for valves specified in this Section.

1.4 CLOSEOUT DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 00 10 - General Requirements

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
 - .2 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse or recycle of crates, packaging materials, padding, and pallets, in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 GENERAL

- .1 All valves used for potable water to have wetted parts suitable for potable water use and be listed for use in potable water systems.
- .2 Where options existing, valves to be lead free or low lead types.

2.2 BALL VALVES

- .1 NPS 2 and smaller: Class 600, bronze body, full bore, forged brass ball, brass gland and PTFE Teflon seat, steel lever handle, screwed.
 - .1 Acceptable material: Kitz Fig 68, Toyo, M.A. Stewart.
- .2 NPS 2 and smaller: Class 600, bronze body, forged brass ball, brass gland and PTFE Teflon seat, steel lever handle, with soldered joint end.
 - .1 Acceptable material: Kitz Fig 69, Toyo, M.A. Stewart.
- .3 NPS 2-1/2 and larger: Class 125, flanged cast iron body, Teflon fused solid ball, blow out proof stainless steel stem, Teflon seats.
 - .1 Acceptable material: American Valve Model 400, M.A. Stewart.

2.3 CHECK VALVES

- .1 NPS 2 and under:
 - .1 To MSS SP-80-1997, Class 125, 860 kPa, bronze body, bronze swing disc, Y-pattern, screw in cap, regrindable seat, soldered.
 - .1 Acceptable material: Kitz Fig 23/Toyo.
 - .2 To MSS SP-80-1997, Class 125, 860 kPa, bronze body, bronze swing disc, Y-pattern, screw in cap, regrindable seat, screwed.
 - .1 Acceptable material: Kitz Fig 22/Toyo.
 - .3 Class 125, 860 kPa, bronze body, bronze disc, lift type, vertical way, screwed ends.
 - .1 Acceptable material: Kitz Fig 26/Toyo.
- .2 NPS 2 1/2 and over:
 - .1 To MSS-SP-71, Class 125, 860 kPa, Cast Iron body, Flat flange faces, renewable seat, bronze disc, bolted cap specified section 23 05 23.02 Valves - Cast Iron: Gate, Globe.

2.4 DRAIN VALVES

- .1 Minimum 13diam, class 600, bronze body, full bore, forged brass ball, brass gland and PTFE Teflon seat, steel lever handle, screwed, male hose end c/w cap and chain.
 - .1 Acceptable material: Kitz /Toyo.

2.5 GATE VALVES

- .1 NPS 2 and under:
 - .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc, screwed or soldered, as specified Section 23 05 23.01 - Valves - Bronze
- .2 Gate valves, NPS 2-1/2 and over, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - .3 Seat rings: renewable bronze screwed into body.
 - .4 Stem: nickel-plated steel, forged T-head disc-stem connection.
 - .5 Pressure rating: Class 125
 - .6 Operator: handwheel.
- .3 Gate valves, NPS 2-1/2 and over, outside screw and yoke (OS&Y), Underwriters Approved:
 - .1 Approvals: UL and FM approved for fire service, label on valve yoke.
 - .2 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B).

- .3 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
- .4 Packing gland: bronze.
- .5 Stem: manganese bronze. Diameter to ULC C-262 (B). Brass, ASTM B16.
- .6 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
- .7 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: EPDM coated cast iron with bronze disc rings.
- .8 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
- .9 Pressure rating: Class 125
- .10 Operator: handwheel.

2.6 FLOW BALANCING VALVE & MEASURING STATION

- .1 Hydronic circuit balancing valve c/w pressure differential read-out ports. Suitable for use with potable water.
- .2 Shut-off: positive drip proof.
- .3 Metering ports: 6mmØ NPT brass, nordel check valves and gasketed caps.
- .4 Drain ports: additional 6mmØ NPT connections with brass plugs.
- .5 Valve Body: Y pattern, equal percentage globe style.
- .6 Construction: Y pattern, bronze body, high strength engineered resin plug with precision contoured channels for uniform flow distribution, bronze stem, high strength resin hand wheel and sleeve, minimum 4-360 turns from full open to full closed, hidden memory feature.
- .7 Insulation jacket: preformed, PVC, to ASTM D 1784/class 14235-C, MEA#7-97, ASTM-E-84 and ASTM-136, flame spread rating 50 or less, insulation to requirements of section 23 07 19 - Thermal Insulation for HVAC piping.
- .8 Connections: sweat or threaded.
- .9 Size: pipe size or as indicated on drawings
- .10 Standard of Acceptance: Armstrong CBV-T or CBV-S circuit balancing valves, Tact, T&A, ITT.

2.7 STRAINERS

- .1 Class 150, 1035 kPa, Y-pattern type with 20 mesh removable stainless-steel screen.
- .2 NPS 2 and under, bronze body, screwed ends, with brass cap.
- .3 NPS 2 1/2 and over, cast iron body, flanged ends, with bolted cap.
- .4 Strainers to be line size.
- .5 Acceptable Material: Kitz, Toyo

Part 3 Execution

3.1 INSTALLATION

- .1 Install using stem valves in upright position with stem above horizontal unless otherwise approved by Consultant.

- .2 Remove internal parts before soldering.
- .3 Install valves with unions or flanges as indicated at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.
- .4 Install to manufacturer's recommendations.
- .5 Maintain proper clearance to permit service and maintenance.
- .6 Should deviations beyond allowable clearances arise, request and follow Engineer's directive.
- .7 Install specified valves at all branch take-offs and as indicated.
- .8 Provide silent check valves in vertical pipes with downward flow and as indicated.
- .9 Provide swing check valves on discharge of pumps as indicated.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .3 Section 23 07 19 - HVAC Piping Insulation

1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 ASTM International (ASTM)
 - .1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-2003, Mineral Fiber Pipe Insulation.
 - .6 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (SDS).
- .5 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

- .7 National Energy Code for Buildings, NECB-2020

1.3 DEFINITIONS

- .1 For purposes of this section:
- .1 "CONCEALED" - insulated mechanical services and equipment in hung ceilings non-accessible chases, furred spaces and crawlspaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.
 - .3 "DW" - refers to DHW, DCW and DHWR piping.
 - .4 "Run outs" - refers to piping to individual terminal units or fixtures not exceeding 3.6m in length.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit Product Data in accordance with Section 01 00 10 - General Requirements
- .2 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
- .3 Provide product data as follows:
- .1 Insulation.
 - .2 Insulation Jackets:
 - .3 Insulation Inserts
 - .4 Insulated Valve Jackets
 - .5 Adhesives
- .4 Provide product data or other documentation for adhesives and sealants used in that clearly shows VOC content (in g/L).

1.5 QUALITY ASSURANCE

- .1 Qualifications:
- .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
- .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 00 10 - General Requirements
 - .3 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .4 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
- .1 Protect from weather, construction traffic.
 - .2 Protect against damage.

- .3 Store at temperatures and conditions required by manufacturer.

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102:
.2 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with ASTM E 84-01, Test Method for Surface Burning Characteristics of Building Materials and CAN/ULC- S102.

2.2 TYPE A-3 INSULATION

- .1 TIAC Code A-3: Rigid molded mineral fibre piping insulation with factory applied vapour retarder jacket to CAN/CGSB-51.9-92 and CGSB SI-GP-52M.
.2 Materials:
.1 Insulation: molded, heavy density one piece, inorganic glass fiber bonded with thermosetting resin.
.2 Jacket: white kraft paper bonded to aluminum foil and reinforced with glass fibers. 3. Lap seal: self adhesive.
.3 Temperature range: -29degC to 454degC
.4 Thermal Conductivity "k" shall not exceed 0.031 W/m. deg.C at 24 deg.C mean temperature when tested in accordance with ASTM C 335-95.
.5 Surface burning characteristics:
.1 To STM E84-98e, Test Method for Surface Burning Characteristics of Building Materials and ANSI/NFPA 255-2000, Burning Characteristics of Building Materials and CAN/ULC-S102-M88.
.2 UL Classified.
.3 Flame spread=25 as plain insulation or composite basis.
.4 Smoke developed=50 as plain insulation or composite basis.
.6 Vapour Transmission:
.1 To ASTM E 96-00e1, Standard Test Methods for Water Vapor Transmission of Materials.
.2 Maximum: 0.02 perms.
.7 Resistance to Fungi and Bacteria:
.1 ASTM listed to not promote growth of fungi or bacteria.
.8 Acceptable material: Knauf Fiberglass Pipe Insulation.

2.3 TYPE A-4 EXTERIOR INSULATION

- .1 Insulation:
.1 Rigid closed cell polyurethane insulation, formed, 50 mm min thickness.
.2 Properties:
.1 Water absorption: 4% by volume.
.2 Density: 35-46kg/m3.

- .3 Compressive strength: 206kPa.
- .4 Thermal conductivity: 0.020 to 0.026 W/m-degC.
- .5 Operating temperatures: -45 to 120degC.
- .3 Polymer Coating:
 - .1 Two component, fully bonded polymer coating on all exterior surfaces.
 - .2 Properties:
 - .1 Density: 1170kg/m3.
 - .2 Thickness: 1.6mm outside surfaces, 0.51mm inside surfaces.
 - .3 Acceptable material: Urecon BL-75-20EP.
- .4 Acceptable material: Urecon.

2.4 REMOVABLE PREFABRICATED INSULATED ENCLOSURES

- .1 Design: to permit periodic removal and replacement without damage to adjacent insulation, to enclose entire equipment body with minimum 50mm overlap at mating flanges or overlaps.
- .2 Insulation:
 - .1 Hot systems: BGF needled E Glass Mat, binder free. Minimum thickness or U value as indicated. Thermal Conductivity "k" shall not exceed 0.031 W/m. deg.C at 24 deg.C mean temperature when tested in accordance with ASTM C 335-95.
 - .2 Cold systems: flexible unicellular, preformed tubular elastomer to CAN/ CGSB-51.40-95, thermal conductivity "k" shall not exceed 0.04 W/m. deg.C at 24 deg.C mean temperature when tested in accordance with ASTM C 335-95, service temperature: -4degC to 100degC.
 - .3 Insulation thickness: to match piping system thermal performance.
- .3 Jacket & lining: ULC listed fiberglass cloth with Teflon coating
 - .1 Liner not required for cold systems.
- .4 Fasteners: Velcro type flap along parting edges. Cinch belts and D-rings as required.
- .5 Quilts: 300SS quilting pins with SS washers.
- .6 ID Tag: printed tags encased in plastic holder.
- .7 Construction: jacket sewn with inside seams formed to fit insulation, insulation secured with quilting pins to jacket.
- .8 Operating range: 0degC to 262degC
- .9 Acceptable material: Reflex style C8 Insulation Covers.

2.5 CEMENT

- .1 Thermal insulating and finish to CAN/CGSB-51.12-95 low VOC to the current content limits of SCAQMD Rule #1168.

2.6 JACKETS

- .1 Canvas:
 - .1 ULC listed plain weave, cotton fabric at 220g/sq.m.
 - .2 Acceptable material: S. Fattal Thermocanvas.

- .2 Polyvinyl Chloride (PVC):
 - .1 One piece premoulded PVC jacketing to AC774.1K82 with 25 flame and 50 smoke rating to ASTM E 84-01.
 - .2 Gloss finish, UV resistant, premoulded for fitting applications, jacket for straight pipe runs.
 - .3 Temperature rating: max insulation surface temperature 60degC.
 - .4 Secure with PVC tape with manufactured. supplied rivets. Tape only is not acceptable.
 - .5 Acceptable material: Knauf Proto LoSmoke Fitting and Covers.
- .3 Aluminum:
 - .1 Apply in accordance with CSA HA Series M1980.
 - .2 Crimped or embossed jacketing 0.6 mm thick with longitudinal slip joints and 50 mm end laps. Aluminum alloy straps with mechanical fasteners.

2.7 INSULATION SECUREMENTS

- .1 Tape: ULC listed, self-adhesive, laminated aluminum foil, glass fibre scrim and paper, 50 mm wide minimum.
- .2 Contact adhesive: Quick setting, asbestos free, low VOC to the current content limits of SCAQMD Rule #1168.
- .3 Tie wire: 1.5 mm diameter stainless steel.
- .4 Bands: Aluminum, 19 mm wide, 0.5 mm thick.
- .5 Lap seal adhesive: quick setting for joints and lap sealing of vapour barriers.
- .6 Lagging Adhesive: fire retardant coating.

2.8 INSULATED HANGER INSERTS

- .1 10kg density molded fiberglass, fibers oriented parallel to the direction of pipe to high compressive strength, noncombustible; fully resistant to water, oils, gasoline or common solvents, or, corrosion, odors, insects and oxidation, operating range
- .2 -84degC to 232degC.
- .3 Length: 300mm.
- .4 Acceptable material: Hamfab H Block.

2.9 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation low VOC to the current content limits of SCAQMD Rule #1168.

2.10 FITTING INSERT INSULATION

- .1 TIAC Code C-2: Mineral fibre blanket insulation with factory applied vapour retarder jacket to CAN/CGSB-51.9-92 and CGSB SI-GP-52M.
- .2 Materials:
 - .1 Insulation: molded, inorganic glass fiber bonded with thermosetting resin.
 - .2 Jacket: kraft paper bonded to aluminum foil and reinforced with glass fibers.

- .3 Lap seal: 50m stapling flange.
- .4 Density: 16kg/m³.
- .3 Temperature range: -29degC to 121degC
- .4 Thermal Conductivity "k" shall not exceed 0.04 W/m. deg.C at 24 deg.C mean temperature when tested in accordance with ASTM C 335-95
- .5 Surface Burning Characteristics:
 - .1 To STM E84-98e, Test Method for Surface Burning Characteristics of Building Materials and ANSI/NFPA 255-2000, Burning Characteristics of Building Materials and CAN/ULC-S102-M88.
 - .2 UL Classified.
 - .3 Flame spread=25 as plain insulation or composite basis.
 - .4 Smoke developed=50 as plain insulation or composite basis.
- .6 Vapour Transmission:
 - .1 To ASTM E 96-00e1, Standard Test Methods for Water Vapor Transmission of Materials.
 - .2 Maximum: 0.02 perms.
- .7 Resistance to Fungi and Bacterial growth:
 - .1 ASTM listed to not promote growth of fungi or bacteria.
- .8 Acceptable material: Knauf.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENT

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

3.2 INSTALLATION (GENERAL)

- .1 Install in accordance with TIAC National Standards and the requirements of ANSI/ NFPA 90A and ANSI/NFPA 90B
- .2 Install all insulation systems including minimum insulation thicknesses to the most stringent requirements of ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings and the Canadian National Energy Code for Buildings unless otherwise noted in the insulation schedule
- .3 Apply materials in accordance with manufacturers instructions and this specification.
- .4 Seal and finish exposed ends as follows:
 - .1 PVC Jacketed insulation: PVC jacket termination.
 - .2 Unfinished insulation: insulation tape.
 - .3 Where insulation not provided at valves, fitting and trim delete insulation and finish away from studs and nuts to permit use of tools without damage to insulation.
- .5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

- .6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

3.3 VALVES

- .1 Concealed ball valves:
 - .1 Insulate all concealed ball valves using specified pipe insulation continuous over valve. Core out insulation as required to suit valve body dimensions or provide one size larger pipe insulation.
 - .2 Provide 25mm thick removable insulation enclosures for the following valves:
 - .1 Where available, manufacturer supplied insulation shell pieces may be used in lieu.
 - .2 Backflow preventers, all sizes
 - .3 Valves NPS 2 and larger: ball, gate, globe and butterfly.
 - .4 Balancing valves NPS 2 and above.

3.4 PIPING

- .1 Insulate piping for full length as per insulation schedule except as follows:
 - .1 Insulate DWV vents from exterior building termination penetration 1500 mm inside building.
 - .2 Insulate STW from exterior building termination penetration 3000 mm inside building.
- .2 Insulation is not required for the following:
 - .1 All chrome plated exposed piping.
 - .2 Flexible tubing systems from distribution manifolds to fixtures where applicable.
 - .3 Where insulation not provided at valves, fitting and trim delete insulation and finish away from studs and nuts to permit use of tools without damage to insulation.
 - .4 Fastenings-Type A3: secure insulation by tape at each end and center of each section, but not greater than 900 mm on centers.

3.5 FINISHES

- .1 PVC:
 - .1 Provide where specified.
 - .2 Provide min 25mm overlap.
 - .3 Secure using flexible PVC tape and manufactured. approved rivets. Do not stretch final 50mm of tape.
- .2 Metal:
 - .1 Provide where specified.
 - .2 Pull up tight. Provide 25mm overlap and secure.
- .3 Canvas:
 - .1 Provide where specified.
 - .2 Install over cement finishes. Seams to be inconspicuous.

3.6 PROTECTION OF INSULATION DURING CONSTRUCTION

- .1 Insulation is to be protected from moisture damage during all stages of construction.
- .2 Where insulation is damaged due to moisture damage either prior to installation, during or subsequent to installation up to and including final inspection replace damaged insulation to the satisfaction of the Engineer.

3.7 PIPE INSULATION SCHEDULE

- .1 Domestic Hot Water and Hot Water Recirculation Pipes (rigid):
 - .1 TIAC code A-1 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
 - .2 Thickness:
 - .1 $\leq 50\text{Ø}$: 25mm
 - .2 $> 50\text{Ø}$: 38mm
 - .3 Jackets:
 - .1 Exposed: PVC
 - .2 Concealed: none
- .2 Domestic Cold Water Pipes (rigid):
 - .1 TIAC code A-3 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
 - .2 Thickness: 25mm
 - .3 Jackets:
 - .1 Exposed: PVC
 - .2 Concealed: none
- .3 Drain waste vent pipes (interior aboveground):
 - .1 TIAC code A-3 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
 - .2 Thickness: 25Ø
 - .3 Jackets:
 - .1 Exposed: PVC
 - .2 Concealed: none
 - .4 Provide for first 1500mm from exterior wall penetration.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 03 - Mechanical Start-Up
- .3 Section 23 08 13 - Performance Verification of HVAC Systems

1.2 REFERENCE STANDARDS

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IES Standard 90.1-2022, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group (CSA)
 - .1 CAN/CSA No. 108, Liquid Pumps.
- .3 Electrical Equipment Manufacturers Association of Canada (EEMAC)
- .4 National Electrical Manufacturers' Association (NEMA)
 - .1 NEMA MG 1-2011, Motors and Generators.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for pump, circulator, and equipment and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.
- .3 Shop Drawings:
 - .1 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.
- .3 Submit electronic copies of operation and maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect hydronic pumps from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 EQUIPMENT

- .1 Size and select components to: CAN/CSA-B214.

2.2 INLINE WET ROTOR CIRCULATORS - CONSTANT VOLUME

- .1 Construction: Aluminum oxide ceramic shaft and radial bearings. Carbon thrust bearing and EPDM retainer. Stainless steel inlet cone, rotor can, rotor cladding, bearing plate, shaft retainer. Corrosion-resistance impeller. EPDM O-ring and gaskets. Composite terminal box. Bronze or stainless-steel pump housing. Integral 3-speed motor and selection switch
- .2 Inline or base mounted as required.
- .3 Rated Pressure: 1000 kPa minimum
- .4 Operating Temperature: 110°C
- .5 Approvals: CSA, UL listed.
- .6 Voltage: as per drawing schedules.
- .7 Acceptable Material: Grundfos UPS stainless steel series
- .8 Schedule: as per drawing schedules.

2.3 INLINE WET ROTOR CIRCULATORS - VARIABLE SPEED

- .1 Construction: Bronze or stainless-steel pump housing, stainless steel rotor can, bearing plate and rotor cladding, ceramic shaft and radial bearings, carbon thrust bearing, composite impeller, EPDM O-ring and gaskets, composite control box. Integral variable speed drive and controller.
- .2 Operating Temperature Range: 2-95°C
- .3 Ambient Temperature Range: 0-55°C
- .4 Rated Pressure: 1000 kPa minimum
- .5 Approvals: CSA, UL listed.
- .6 Voltage: as per drawing schedules.
- .7 Acceptable Material: Grundfos ALPHA stainless steel series or MAGNA stainless steel series
- .8 Schedule: as per drawing schedules.

2.4 INLINE VERTICAL MULTI-STAGE PUMP - VARIABLE SPEED

- .1 General:
 - .1 The pumps shall be of the in-line vertical multi-stage design
 - .2 The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.
- .2 Small Vertical In-Line Multi-Stage Pumps (12mm or 16mm shaft, Nominal flow from 3 to 125 gallons per minute):
 - .1 The pump impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement.
 - .2 The suction/discharge base shall have ANSI Class 250 flange or internal pipe thread (NPT) connections as determined by the pump station manufacturer.
 - .3 Construction:
 - .1 Suction/discharge base, pump head, motor stool: 304 stainless steel
 - .2 Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel.
 - .3 Shaft: 316 Stainless Steel.
 - .4 Impeller wear rings: 304 Stainless Steel.
 - .5 Shaft journals and chamber bearings: Silicon Carbide.
 - .6 O-rings: EPDM.
 - .7 Shaft couplings: cast iron or sintered steel.
 - .8 Shaft Seal shall be balanced o-ring cartridge type:
 - .1 Collar, Drivers, Spring: 316 Stainless Steel.
 - .2 Shaft Sleeve, Gland Plate: 316 Stainless Steel.
 - .3 Stationary Ring: Silicon Carbide (Graphite Imbedded).
 - .4 Rotating Ring: Silicon Carbide (Graphite Imbedded).
 - .5 O-rings: EPDM.
 - .9 Shaft seal shall be replaceable without removal of any pump components other than the coupling guard, shaft coupling and motor.
 - .3 Integrated Variable Frequency Drive Motor
 - .1 A. Each motor shall be of the Integrated Variable Frequency Drive design consisting of a motor and a Variable Frequency Drive (VFD) with a built-in pump system controller. The complete VFD/motor assembly shall be built and tested as one unit by the same manufacturer.
 - .2 The VFD/motor shall have an IP55 (TEFC) enclosure rating as a complete assembly. The motor shall have a standard NEMA C-Face, Class F insulation with a Class B temperature rise.
 - .3 The VFD shall be of the PWM (Pulse Width Modulation) design using up to date IGBT (Insulated Gate Bipolar Transistor) technology.
 - .4 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of the motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating.

- .5 The VFD shall have, as a standard component, an RFI filter (Radio Frequency Interference) to minimize electrical noise disturbances between the power electronics and the power supply. The VFD/motor shall meet all requirements of the EMC directive concerning residential and light industry equipment (EN 61800-3).
 - .6 The VFD shall have a minimum of two skip frequency bands which can be field adjustable.
 - .7 The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current.
 - .8 The VFD/motor shall include protection against input transients, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature. The motor over-temperature protection shall consist of three series connected PTC thermistors, one for each motor phase.
 - .9 The VFD/motor shall provide full nameplate output capacity (horsepower and speed) within a balanced voltage range.
 - .10 Automatic De-Rate Function: The VFD/motor shall reduce speed during periods of overload allowing for reduced capacity pump operation without complete shut-down of the system. Detection of overload shall be based on continuous monitoring of current, voltage and temperature within the VFD/motor assembly.
 - .11 The VFD/motor shall have, as a minimum, the following input/output capabilities:
 - .1 Speed Reference Signal: 0-10 VDC, 4-20mA.
 - .2 Digital remote on/off.
 - .3 Fault Signal Relay (NC or NO).
 - .4 Fieldbus communication port (RS485).
 - .12 Motor drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump at full rated speed.
- .4 Pump System Controller and User Interface
- .1 The pump system controller (Proportional-Integral) shall be a standard component of the integrated variable frequency drive motor developed and supported by the pump manufacturer.
 - .2 The pump system controller shall have an easy to use interface mounted on the VFD/motor enclosure. Pump system start/stop and set-point adjustment shall be possible through the use of two push buttons located on the drive enclosure
 - .3 The VFD/motor shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote on/off (digital) signal.
 - .4 Pump status and alarm state shall be indicated via two LED lights located on the VFD/motor enclosure.
 - .5 Advanced programming and troubleshooting shall be possible via an infra-red hand held programmer or a field connected personal computer. Pump system programming (field adjustable) shall include as a minimum the following:
 - System Pressure set-point, psig,
 - System start pressure, psig,
 - System Stop pressure, psig,
 - Minimum Pump Speed, %,

- Pressure Transducer supply/range Maximum Pump Speed, %,
 - System Time (Proportional Gain) Integral Action Time.
- .6 The infra-red programmer shall be capable of displaying the following status readings:
- Pump Status (on, off, min., max.),
 - System Set-point, psig,
 - Actual system pressure, psig,
 - Remote set-point, %,
 - Pump speed, rpm,
 - VFD/Motor input power, kW,
 - VFD/Motor total cumulative kWh,
 - VFD/Motor total operating hours.
- .7 The infra-red programmer shall also be capable of displaying the following alarms, with the last five alarms stored in memory:
- Loss of sensor signal,
 - Loss of external set-point signal,
 - Under-voltage & Over-voltage,
 - Motor overload (blocked pump),
 - Motor over-temperature,
 - Drive over-temperature,
 - Drive Over-current.
- .5 Acceptable material: Grundfos CRE.
- .6 Schedule: as per drawing schedules.

2.5 DOMESTIC WATER BOOSTER SYSTEM

- .1 Packaged triplex system, factory assembled, tested and adjusted, ready for site piping and electrical connections.
- .2 Total Capacity:
- .1 Flow rate: 2.801 L/s.
 - .2 System pressure: 413 kPa.
 - .3 Available pressure at metre outlet: 276 kPa.
 - .4 Triplex system with 2 pumps sized for 95% of the maximum flow, pumps in lead/lag/lag operation.
- .3 Pumps in accordance with clause 2.4 - Inline vertical multi-stage pump - variable speed
- .4 Valves: to Section 22 05 23 - Valves for Plumbing Piping. Suction and discharge gate or butterfly valves and pressure reducing and check valve for each pump connected to common suction and discharge headers.
- .5 Supports: install complete package on factory fabricated structural steelwork designed to withstand seismic forces as determined by the contractor's retained seismic engineer.
- .6 Anchor Bolts and Templates:
- .1 Supply for installation by other Divisions.

- .2 Size anchor bolts to withstand seismic forces as determined by the contractor's retained seismic engineer.
- .7 Control Panel: CSA 1 enclosure complete with:
 - .1 Externally operated disconnect switch.
 - .2 Magnetic across-the-line fused starters.
 - .3 Overload protection for each phase.
 - .4 Adjustable pressure switches.
 - .5 Low pressure safety cut-out.
 - .6 Control circuit transformer with fused secondary.
 - .7 Adjustable time delay relay.
 - .8 Hand-off-automatic selector switch for pumps.
 - .9 Pressure and suction gauges, 90 mm nominal dia., range 0 to 689 kPa.
 - .10 Pilot lights; power on, low suction pressure.
 - .11 Lead/lag selector switch.
 - .12 Alarm: visual and audible with silencing switch for abnormal conditions.
- .8 Operation:
 - .1 Lead pump to operate continuously during demand.
 - .2 Should operating pump fail, next pump in sequence to start automatically.
 - .3 Should system demand exceed capacity of operating pump or pumps, next pump in sequence automatically starts.
 - .4 Adjustable 90 time delay to maintain starting pump operation and avoid "on-off " cycling.
 - .5 Constant pressure control, pressure switch to cycle pump.
 - .6 Low suction pressure switch to stop pumps.
 - .7 Temperature control for low or no system demand to bleed to drain.
- .9 Acceptable material: Grundfos Hydro Multi-B/E with Grundfos CME pumps.

2.6 CONDENSATE PUMP

- .1 General
 - .1 Two-piece condensate pump design allows the reservoir to be placed remote from the pump-controller is located outside the air handler. The two components are connected via a convenient communications wire and suction tubing.
 - .2 Designed to accommodate multiple electrical requirements within one pump. The DV suffix indicates that the pump is capable of operating from a wide range of supply voltage to maintain consistent pump performance.
 - .3 Suitable for intermittent use with a maximum 50% duty cycle and maximum 3 minute pump ON cycle.
- .2 Pump
 - .1 The pump is controlled by a float switch mechanism, which automatically starts and stops the pump. These models also include a high water level switch, which can be reconfigured to signal a building management system.

- .1 Normally-closed relay rated at 8 A resistive - 250 V alarm
- .2 Low noise, 21 dB(A)
- .3 1/4" I.D. pump discharge outlet
- .4 Elastomeric mounting grommets on pump housing bracket and elastomeric passive vibration isolator used to dampen pump vibration.
- .5 3.3' communications cable (pump to reservoir), 60" power cable
- .6 Ambient temperature range 0°C to 60°C, Maximum water temperature 60 °C
- .3 Reservoir
 - .1 Clear reservoir remote from pump (up to 3.3 ft) for instant visual inspection of water level, float, and filter
 - .2 Hall effect on/off level sensors with high-water sensor feature
 - .3 Extra-large filter screen for longer intervals between cleaning
 - .4 Multi-step drain hose adapter (1/2", 5/8", and 3/4")
 - .5 Complete with reservoir mounting kit
- .4 Power: 110 to 240V single phase, 18 W
- .5 Acceptable material: Little Giant EC-1-DV Series

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 INSTALLATION

- .1 In line circulators: install as indicated by flow arrows.
 - .1 Support at inlet and outlet flanges or unions.
 - .2 Install with bearing lubrication points accessible.
- .2 Base mounted type: supply templates for anchor bolt placement.
 - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
 - .2 Align coupling in accordance with manufacturer's recommended tolerance.
 - .3 Check oil level and lubricate. After run-in, tighten glands.
- .3 Ensure that pump body does not support piping or equipment.
 - .1 Provide stanchions or hangers for this purpose.
 - .2 Refer to manufacturer's installation instructions for details.
- .4 Pipe drain tapping to floor drain.
- .5 Install volute venting pet cock in accessible location.
- .6 Check rotation prior to start-up.
- .7 Install pressure gauge test cocks.

3.3 START-UP

- .1 General:

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements; supplemented as specified herein.
- .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
 - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
 - .2 After starting pump, check for proper, safe operation.
 - .3 Check base for free-floating, no obstructions under base.
 - .4 Run-in pumps for 12 continuous hours minimum.
 - .5 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .6 Eliminate air from scroll casing.
 - .7 Adjust water flow rate through water-cooled bearings.
 - .8 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
 - .9 Adjust alignment of piping and conduit to ensure true flexibility.
 - .10 Eliminate cavitation, flashing and air entrainment.
 - .11 Adjust pump shaft seals, stuffing boxes, glands.
 - .12 Measure pressure drop across strainer when clean and with flow rates as finally set.

3.4 PERFORMANCE VERIFICATION (PV) PRESSURE BOOSTER PUMPS

- .1 General:
 - .1 In accordance with Section 01 91 13 - General Commissioning Requirements: General Requirements, supplemented as specified.
- .2 Obtain manufacturer's approval, before performing PV, to ensure warranties remain intact.
- .3 Application tolerances:
 - .1 Flow: +/- 10 %.
 - .2 Pressure: Plus 20 %, minus 5 %.
- .4 PV procedures:
 - .1 Open pump balancing valve fully.
 - .2 Measure differential pressure (DP) across pump.
 - .3 Measure amperage and voltage and compare with manufacturer's data sheets and motor nameplate data.
 - .4 If suction is different size than discharge connection, add velocity head correction factor to DP.
 - .5 Mark this DP on manufacturer's pump curve.
 - .6 If flow rate is higher than specified, slow close balancing valve until specified DP is reached.
 - .7 Repeat measurements of amps and volts. Compare with manufacturer's data sheets.

- .8 Calculate BHP and compare with nameplate data.

3.5 REPORTS

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements: reports, supplemented as specified.
- .2 Include:
 - .1 PV results on approved PV Report Forms.
 - .2 Product Information report forms.
 - .3 Pump performance curves (family of curves) with final point of actual performance.

3.6 TRAINING

- .1 In accordance with Section 01 00 10 - General Requirements and Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel, supplemented as specified.
- .2 Provide instruction on equipment and systems operation and maintenance described in this section with the following minimum durations:
 - .1 Water pressure booster pump package: 1 hour
 - .2 General recirculation pumps: 30 mins
 - .3 Condensate pumps: 15 mins

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 22 05 00 - Common Work Results for Plumbing
- .3 Section 22 05 23 - Valves for Plumbing Piping
- .4 Section 23 05 15 - Common Installation Requirements of HVAC Pipework
- .5 Section 23 05 23.01 - Valves - Bronze
- .6 Section 23 05 23.02 - Valves - Cast Iron
- .7 Section 23 05 29 - Hangers and Supports for HVAC piping and equipment.
- .8 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers International (ASME)
 - .1 ANSI/ASME B16.15-13, Cast Copper Alloy Threaded Fittings, Classes 125 and 250.
 - .2 ANSI/ASME B16.18-12, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22-13, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.24-11, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
 - .5 ASME B16.26-13, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .6 ASME B31.9-14, Building Services Piping.
 - .7 ASME B36.19M-04, Stainless Steel Pipe.
- .2 ASTM International (ASTM)
 - .1 ASTM A182/A 182M-16, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - .2 ASTM A269-15a, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - .3 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .4 ASTM A312/A312M-16, Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - .5 ASTM A351/A351M-16, Castings, Austenitic, for Pressure Containing Parts.
 - .6 ASTM A403/A403M-16, Wrought Austenitic Stainless Steel Piping Fittings.
 - .7 ASTM A536-84 (2014), Standard Specification for Ductile Iron Castings.
 - .8 ASTM B32-08 (2014), Standard Specification for Solder Metal.
 - .9 ASTM B42-15a, Seamless Copper Tube, Standard Sizes.

- .10 ASTM B88M-14, Standard Specification for Seamless Copper Water Tube (Metric).
- .11 ASTM F876-15, Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
- .12 ASTM F877-11, Standard Specification for Crosslinked Polyethylene (PEX) Hot and Cold Water Distribution System.
- .3 American National Standards Institute/American Water Works Association (ANSI)/(AWWA)
 - .1 ANSI/AWWA C111/A21.11-12, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - .2 ANSI/AWWA C151/A21.51-09, Ductile Iron Pipe, Centrifugally Cast, for Water.
 - .3 AWWA C904-06, Crosslinked Polyethylene (PEX) Pressure Pipe, ½ In. (12 mm) through 3 In. (76mm), for Water Service.
- .4 CSA Group (CSA)
 - .1 CSA B137.5-13, Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications.
 - .2 CSA B242-05, Groove and Shoulder Type Mechanical Pipe Couplings.
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S101-07, Fire Endurance Tests of Buildings Construction and Materials.
 - .2 CAN/ULC S102.2-10, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies.
 - .3 CAN/ULC S115-11, Standard Method of Fire Tests of Firestop.
- .6 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67-02a, Butterfly Valves.
 - .2 MSS-SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-05, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
- .7 National Research Council (NRC)
 - .1 National Plumbing Code of Canada (NPC) 2020.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data
 - .1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 00 10 - General Requirements

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Packaging Waste Management: remove for reuse or recycling of packaging materials, crates, padding and pallets in accordance with Section 01 00 10 - General Requirements
- .2 Place materials defined as hazardous or toxic in designated containers.

1.5 NON-APPLICABLE SYSTEMS

- .1 Piping and fittings described in this section are NOT applicable for the following systems:
 - .1 Reverse Osmosis (RO) water systems downstream of inlet connection to RO unit. Refer to Section 22 13 19 - PVC Process Piping.

Part 2 Products

2.1 PIPING

- .1 Domestic hot, cold and recirculation systems, within building.
 - .1 Above ground:
 - .1 Copper tube, hard drawn, type L: to ASTM B88M.
 - .2 PEX Piping to CSA B137.5.
 - .3 Stainless steel, schedule 10, type 304/304L or 316/316L: to ASME B36.19M, ASTM A312/A312M, or ASTM 269
 - .2 Buried or embedded:
 - .1 Copper tube, soft annealed, type L: to ASTM B88M, in long lengths and with no buried joints.
 - .2 PEX Piping to CSA B137.5.

2.2 FITTINGS

- .1 Bronze pipe flanges and flanged fittings, Class 150: to ANSI/ASME B16.24.
- .2 Cast bronze threaded fittings, Class 125: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI/ASME B16.18.
- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
- .5 NPS 2 and larger:
 - .1 ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242.
- .6 NPS 2-1/2 and larger:
 - .1 ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242.
 - .1 Stainless steel fittings where piping is stainless steel.
- .7 NPS 2 and smaller:
 - .1 Wrought copper to ANSI/ASME B16.22 ; with 301 stainless steel internal components and EPDM seals. Suitable for operating pressure to 1380 kPa.
 - .2 PEX fittings to CSA B137.5.

2.3 JOINTS

- .1 Rubber gaskets, latex-free, 1.6 mm thick: to AWWA C111.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.

- .3 Solder: Lead-free.
- .4 Teflon tape: for threaded joints.
- .5 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM gasket.
- .6 Dielectric connections between dissimilar metals: dielectric fitting, complete with thermoplastic liner.
- .7 NPS 1 ½ and smaller: PEX fittings to CSA B137.5.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install in accordance with NPC.
- .2 Install pipe work in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework, supplemented as specified herein.
- .3 Assemble piping using fittings manufactured to ANSI and Standard Council of Canada (SCC) standards.
- .4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.
- .5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .6 Valves
 - .1 Isolate equipment, fixtures and branches with ball valves.
 - .2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

3.3 INSTALLATION - GROOVED

- .1 Install pipe work in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework, supplemented as specified herein.
- .2 Use of special lubricants to protect the gasket for chemical and temperature service are not acceptable.
- .3 During installation, lubricate gasket lips and exterior with thin coat of manufacturer approved lubricant to ease installation and reduce gasket pinching.
- .4 Use roll grooving systems and tools in accordance with manufacturers specifications. Use roll tools to suit piping type.

3.4 INSTALLATION - PEX

- .1 Install pipe work in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework, supplemented as specified herein.
- .2 Install in accordance with the National Plumbing Code.

- .3 PEX tubing systems are suitable for use in the following locations:
 - .1 Concealed locations from DW manifolds (headers) to fixture stops.
 - .2 Concealed locations from trap seal primers to floor drain traps.
 - .3 Domestic Hot Water Return.
 - .4 Maximum acceptable size: 19mmØ unless otherwise noted.
- .4 Piping supports and hangers in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .5 Assemble tubing using fittings manufactured to ASTM standards.
- .6 PEX to copper stub-outs to be used at all fixture stub-outs where PEX piping used.
- .7 Secured to proper backing in the walls with wing back 90° elbows.
- .8 Install pipette bushings where piping passes through steel studs.
- .9 Install in accordance with the tubing manufacturer's recommendations and as indicated in the installation handbook.
- .10 Do not install PEX tubing within 152 mm of appliance vents or within 305 mm of any recessed light fixtures.
- .11 Do not solder within 457 mm of PEX tubing in the same waterline. Make sweat connections prior to making PEX connections.
- .12 Do not expose PEX tubing to direct sunlight for more than 30 days.
- .13 Ensure no glues, solvents sealants or chemicals come in contact with the tubing without prior permissions from the tubing manufacturer.
- .14 Protect PEX tubing with sleeves where abrasion may occur.
- .15 Use strike protectors where PEX tubing penetrates a stud or joist and has the potential for being struck with a screw or nail.
- .16 Use tubing manufacturer-supplied bend supports where bends are less than six times the outside tubing diameter.
- .17 Minimum horizontal supports are to be installed not less than 800 mm centres or in accordance with local plumbing codes and the manufacturers directions.
- .18 Firestopping: in accordance with ASTM E814.
- .19 All PEX tubing to be installed by manufacturer trained and certified tradesperson. Provide certification for review by Consultant if requested.

3.5 STORAGE AND PROTECTION OF PEX TUBING

- .1 Store protected from exposure to harmful environmental conditions and at temperature humidity conditions recommended by the manufacturer.
- .2 Store PEX tubing in cartons or under cover to avoid dirt or foreign material from being introduced into the tubing.
- .3 Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, provide cover to portions of tubing exposed to direct sunlight.

3.6 VALVES

- .1 Isolate equipment, fixtures and branches with ball valves.

3.7 PRESSURE TESTS

- .1 Conform to requirements of Section 23 05 15 - Common installation requirements for HVAC pipework.
- .2 Test pressure: greater of 1 times maximum system operating pressure or 860 kPa.

3.8 PRE-START-UP INSPECTIONS

- .1 Systems to be complete, prior to flushing, testing and start-up.
- .2 Verify that system can be completely drained.
- .3 Ensure that pressure booster systems are operating properly.
- .4 Ensure that air chambers, expansion compensators are installed properly.

3.9 FLUSHING AND CLEANING

- .1 Flush entire system for 8 h. Ensure outlets flushed for 2 hours. Let stand for 24 hours, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean copper. Let system flush for additional 2 hours, then draw off another sample for testing.
 - .1 One sample from Cafe/kitchenette sink
 - .2 One sample from washrooms immediately adjacent Dry Labs and Dry Lab Prep Room
 - .3 One from Dry Lab Prep Room hand washing sink

3.10 DISINFECTION

- .1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction.
- .2 Supply materials and test kit to carry out disinfection as follows:
 - .1 Fill piping system and tanks with chlorine/water solution with a strength of at least 50 mg/L. Ensure pipe is full and no air pockets remain.
 - .2 Leave solution in piping system for 24 hours, while maintaining a pressure of 175 kPa.
 - .3 After 24 hours sample and test the chlorine solution. If the chlorine residual is at least 25 mg/L, the disinfection will be considered successful. Flush chlorine solution from the system. Protect against contamination of the disinfected system.
- .3 If the chlorine residual is less than 25 mg/L, flush the system, clean any deleterious material, re-flush and disinfect again. Repeat until satisfactory.
- .4 If, in the opinion of the Engineer, any component of the potable water system becomes contaminated after disinfection, it shall be flushed and disinfected again at no additional cost.
- .5 Obtain water sample off longest run. Test in approved laboratory for bacteriological analysis and provide certification that all samples are suitable for human consumption prior to interim-occupancy inspection.
- .6 Upon completion, provide laboratory test reports on water quality for Consultant approval.

3.11 START-UP

- .1 Timing: start up after:

- .1 Pressure tests have been completed.
- .2 Disinfection procedures have been completed.
- .3 Certificate of static completion has been issued.
- .4 Water treatment systems operational.
- .2 Provide continuous supervision during start-up.
- .3 Start-up procedures:
 - .1 Establish circulation and ensure that air is eliminated.
 - .2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
 - .3 Monitor piping hot and cold water piping systems for freedom of movement, pipe expansion as designed.
 - .4 Check control, limit, safety devices for normal and safe operation.
- .4 Rectify start-up deficiencies.

3.12 OPERATION REQUIREMENTS

- .1 Co-ordinate operation and maintenance requirements including, cleaning and maintenance of specified materials and products with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

3.13 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 07 92 00 - Joint Sealants
- .3 Section 22 05 00 - Common Work Results for Plumbing
- .4 Section 23 05 02 - Pipe Work Testing
- .5 Section 23 05 15 - Common Installation Requirements for HVAC Pipework
- .6 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

1.2 REFERENCES

- .1 ASTM International Inc
 - .1 ASTM B32-08, Standard Specification for Solder Metal.
 - .2 ASTM B306-02, Standard Specification for Copper Drainage Tube (DWV).
 - .3 ASTM C564-03a, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B67-1972(R1996), Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
 - .2 CAN/CSA-B70-06, Cast Iron Soil Pipe, Fittings and Means of Joining.
 - .3 CAN/CSA-B125.3-05, Plumbing Fittings.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-00, Commercial Adhesives.
- .4 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .5 National Research Council Canada (NRC)
 - .1 National Plumbing Code of Canada 2020 (NPC).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

- .3 Packaging Waste Management: remove for reuse and return of padding in accordance with Section 01 00 10 - General Requirements

1.5 NON-APPLICABLE SYSTEMS

- .1 Piping and fittings described in this section are NOT applicable for the following systems:
 - .1 Radon mitigation vent piping. Refer to Section 22 13 19 - PVC Process Piping.
 - .2 Chemical storage cabinet vent piping. Refer to Section 22 13 19 - PVC Process Piping.

Part 2 Products

2.1 COPPER TUBES AND FITTINGS

- .1 Above ground sanitary and vent Type DWV to: ASTM B306.
 - .1 Fittings:
 - .1 Cast brass: to CAN/CSA-B125.3.
 - .2 Wrought copper: to CAN/CSA-B125.3.
 - .2 Solder: lead free, tin-95:5, type TA, to ASTM B32.

2.2 CAST IRON PIPING AND FITTINGS

- .1 Buried sanitary and vent minimum NPS 3, to: CAN/CSA-B70, with one layer of protective asphaltic coating
 - .1 Joints:
 - .1 Mechanical Joints:
 - .1 Neoprene or butyl rubber compression gaskets: to CAN/ CSA-B70.
 - .2 Stainless steel clamps.
 - .2 Hub and Spigot:
 - .1 Neoprene gasket: to CSA B70.
 - .2 Cold caulking compounds.
 - .2 Above ground sanitary and vent: to CAN/CSA-B70.
 - .1 Joints:
 - .1 Hub and Spigot:
 - .1 Neoprene gasket: to CSA B70.
 - .2 Mechanical Joints:
 - .1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 In accordance with section 23 05 15 - Common installation requirements for HVAC pipework.
- .2 Install in accordance with National Plumbing Code.
- .3 Install piping parallel and close to walls to conserve headroom and space, and grade as indicated as per NPC.
- .4 Use of cast iron/copper DWV piping is mandatory for the following locations:
 - .1 DWV vent through roof for min 1500 mm to roof penetration and through roof.
 - .2 All hydronic heat traced piping.
 - .3 All piping located in non-accessible utilidors.
- .5 Use of cast iron/copper DWV is acceptable in all other locations in the building with the following exceptions:
 - .1 Within 1500mm of urinals use PVC.

3.3 TESTING

- .1 Pressure test buried systems before backfilling.
- .2 Test system in accordance with Section 23 05 02 Pipework Testing supplemented as specified herein.
- .3 Hydraulically test to verify grades and freedom from obstructions.

3.4 PERFORMANCE VERIFICATION

- .1 Cleanouts:
 - .1 Ensure accessible and that access doors are correctly located.
 - .2 Open, cover with linseed oil and re-seal.
 - .3 Verify that cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.
- .3 Storm water drainage:
 - .1 Verify domes are secure.
 - .2 Ensure weirs are correctly sized and installed correctly.
 - .3 Verify provisions for movement of roof system.
- .4 Ensure that fixtures are properly anchored, connected to system and effectively vented.
- .5 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

3.5 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
- .2 Waste Management: separate waste materials for reuse in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 02 - Pipework Testing
- .3 Section 07 92 00 - Joint Sealants
- .4 Section 22 05 00 - Common Work Results for Plumbing
- .5 Section 23 05 02 - Pipework Testing
- .6 Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .7 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

1.2 REFERENCES

- .1 ASTM International Inc.
 - .1 ASTM D2564-04e1, Standard Specification for Solvent Cements for Poly (Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .2 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-Series B1800-06, Thermoplastic Nonpressure Pipe Compendium-B1800 Series.
 - .2 CAN/CSA B181.2, PVC Drain, Waste and Vent Pipe and Pipe Fittings.
 - .3 CAN/CSA B181.12, Recommended Practice for the Installation of PVC Drain, Waste and Vent Pipe and Pipe Fittings.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-00, Commercial Adhesives.
- .4 Health Canada/Workplace Hazardous materials Information System (WHMIS)
 - .1 Material safety Data Sheets (MSDS)
- .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6 National Research Council Canada (NRC)
 - .1 National Plumbing Code of Canada 2015 (NPC).

1.3 NON-APPLICABLE SYSTEMS

- .1 Piping and fittings described in this section are NOT applicable for the following systems:
 - .1 Radon mitigation vent piping. Refer to Section 22 13 19 - PVC Process Piping.
 - .2 Chemical storage cabinet vent piping. Refer to Section 22 13 19 - PVC Process Piping.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:

- .1 Provide manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Provide for the following:
 - .1 PVC DWV piping and fittings
 - .2 PVC primer.
 - .3 PVC solvent cement.
- .3 Provide product data or other documentation for primer and cement that clearly shows VOC content (in g/L)

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 PIPING AND FITTINGS

- .1 For buried and above ground DWV piping to:
 - .1 CAN/CSA-Series B181.2
 - .2 General: PVC.
 - .1 Flame spread rating: less than 25
 - .2 Acceptable material: IPEX System 15 PVC-DWV.
 - .1 IPEX System XFR PVC-DWV may also be used but is not required.

2.2 JOINTS

- .1 Solvent Cement:
 - .1 General: low VOC suitable for PVC pipe.
 - .2 Approvals: ASTM D2564, SCAQMD Rule 1168/316A, Uniform Plumbing Code seal.
 - .3 Colour: grey
 - .4 Resin: PVC
 - .5 MAX VOC Emissions: 510 g/L per SCAQMD Rule 1168, Method 316A
 - .6 Acceptable material: IPEX System 15, XFR 15-50.
- .2 Primer:
 - .1 General: low VOC suitable for PVC pipe.
 - .2 Approvals: ASTM D-F-656, SCAQMD Rule 1168/316A, Uniform Plumbing Code seal.

- .3 Color: purple
- .4 MAX VOC Emissions: 650 g/L per SCAQMD Rule 1168, Method 316A.
- .5 Acceptable materials: Ipex System XFR 15-50

2.3 ACID RESISTANT PIPING

- .1 General: Polypropylene chemical waste drainage piping with excellent resistance to most common organic and mineral acids, their salts, strong and weak alkalis, and most organic chemicals.
- .2 Approvals: Pipe and fittings certified to CAN/CSA B181 .3 requirements
- .3 Material: Fire retardant polypropylene (FRPP): molded from proxylene blue line resin (polypropylene Type II copolymer with fire retardant additives), a flame retardant thermoplastic material
- .4 Pressure rating: schedule 40
- .5 Temperature rating: max 104°C
- .6 Fittings: no-hub FRPP, pre-grooved at factory
- .7 Couplings: no-hub mechanical couplings, stainless steel outer coupling, FRPP inner coupling pre-grooved at factory
- .8 Acceptable material: Watts Orion Blue line FRPP with No-Hub FRPP Couplings and fittings

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 In accordance with Section 23 05 05 - Installation of Pipework
- .2 Install in accordance with National Plumbing Code.
- .3 Piping supports and hangers in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .4 Install piping parallel and close to walls to conserve headroom and space, and grade as indicated as per NPC.
- .5 Install PVC drain, waste and vent pipe and pipe fittings in accordance with CSA B1800 and to the manufacturers listings.
- .6 Provide specified fire stopping systems for piping through fire rated walls and floors where required.
- .7 Listed PVC DWV piping and fittings acceptable throughout building with the following exceptions:
 - .1 Use in Vertical Shafts as defined by NBCC is not acceptable.
 - .2 Use on hydronic heat traced piping is not acceptable.

3.3 ACID RESISTANT PIPING

- .1 Install in accordance with National Plumbing Code and with manufacturer's instructions.
- .2 Acid resistant piping to be used and elsewhere as
 - .1 From outlet of all laboratory sinks (LS-#) to inlet of acid neutralizers located in millwork below .
 - .2 From outlet of all fume hood cup sinks to inlet of acid neutralizers located in millwork below .
 - .3 Where indicated on drawings.

3.4 TESTING

- .1 Pressure test buried systems before backfilling.
- .2 Test system in accordance with Section 23 05 02 - Pipework Testing supplemented as specified herein.
- .3 Hydraulically test to verify grades and freedom from obstructions.

3.5 PERFORMANCE VERIFICATION

- .1 Cleanouts:
 - .1 Ensure accessible and that access doors are correctly located.
 - .2 Open, cover with linseed oil and re-seal.
 - .3 Verify cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.
- .3 Storm water drainage:
 - .1 Verify domes are secure.
 - .2 Ensure weirs are correctly sized and installed correctly.
 - .3 Verify provisions for movement of roof system.
- .4 Ensure fixtures are properly anchored, connected to system and effectively vented.
- .5 Affix applicable label (storm, sanitary, vent, pump discharge) c/w directional arrows every floor or 4.5 m (whichever is less).

3.6 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 22 05 00 - Common Work Results for Plumbing
- .3 Section 22 05 23 - Valves for Plumbing Piping
- .4 Section 23 05 02 - Pipework Testing
- .5 Section 23 05 15 - Common Installation Requirements of HVAC Pipework
- .6 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .7 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM) International Inc.
 - .1 ASTM D1785 Standard specification for poly Vinyl Chloride (PVC) plastic pipe, schedules 40, 80 and 120.
 - .2 ASTM D2467, PVC plastic pipe fittings, schedule 80
 - .3 ASTM D2564-04e1, Standard Specification for Solvent Cements for Poly (Vinyl-Chloride) (PVC) Plastic Piping Systems
- .2 Canadian Standards Association (CSA International)
 - .1 CAN/CSA B137.3 - PVC pipe for pressure applications
 - .2 CAN/CSA B181.2, PVC Drain, Waste and Vent Pipe and Pipe Fittings.
 - .3 CAN/CSA B181.12, Recommended Practice for the Installation of PVC Drain, Waste and Vent Pipe and Pipe Fittings.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-00, Commercial Adhesives.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6 National Research Council (NRC)
 - .1 National Plumbing Code of Canada (NPC) 2020.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data
 - .1 Provide manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide for the following:
 - .1 PVC piping and fittings

- .2 PVC primer.
- .3 PVC solvent cement.
- .3 Provide product data or other documentation for primer and cement that clearly shows VOC content (in g/L)

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets in accordance with Section 01 00 10 - General Requirements

1.5 APPLICABLE SYSTEMS

- .1 Piping and fittings described in this section are applicable for the following systems:
 - .1 Reverse Osmosis (RO) water systems downstream of inlet connection to RO unit.
 - .2 Radon mitigation vent piping
 - .3 Chemical storage cabinet vent piping

Part 2 Products

2.1 PROCESS PIPING & FITTINGS

- .1 Pipe:
 - .1 Sched 40 PVC pipe manufactured of 12454B resin
 - .2 Flame spread rating: maximum 10 in conformance with CAN ULC S102.2
 - .3 Certification:
 - .1 Third party certified to CSA B137.3.
 - .2 To requirements of ASTM D1785 and ASTM D2665.
 - .3 Operating temperature: to 60degC.
 - .4 Operating pressure (100dia. pipe): 1514kPa at 23degC.
 - .5 Acceptable material: IPEX Xirtec 140.
- .2 Joints
 - .1 Socket with solvent joints to manufacturers recommendations
 - .2 Flanges: plain face, socket.
 - .3 Threaded (PVC to PVC only): NPT, socket to PVC. Direct threading of PVC piping is not acceptable.
 - .4 Flange gaskets: EPDM to ANSI B16.21 or ANSI B16.20.
 - .5 Bolts and nuts: to ANSI B18.2.1 - 1981(R1992)
 - .6 Threaded (PVC to other): not acceptable on schedule 40 piping.
- .3 Fittings (Injection Molded-200dia. and smaller unless otherwise noted):

- .1 Sched 40 injection molded manufactured to PVC resin with cell classification of 12454B to ASTM D2466.
- .2 Certification:
 - .1 Third party certified to CSA B137.3.
 - .2 To requirements of ASTM D2466 and ASTM D2467.
 - .3 Operating pressure and temperature: to match piping.
- .4 Cements and Primers:
 - .1 Cement
 - .1 High strength solvent cement to ASTM D-2564.
 - .2 Type: medium setting rate and medium body suitable up to 300dia
 - .3 Low VOC suitable to SCAQMD Rule 1168/316A with maximum
 - .4 VOC Emissions: 650G/L per SCAQMD Rule 1168, Method 316A
 - .2 Primer:
 - .1 Aggressive PVC primer suitable for use in cold temperatures.
 - .2 Low VOC suitable to SCAQMD Rule 1168/316A with maximum VOC Emissions: 650G/L per SCAQMD Rule 1168, Method 316A.

2.2 VALVES

- .1 Butterfly valves:
 - .1 Valve and Body: PVC resin valve body and disc to ASTM D-1784
 - .2 Seats: EPDM
 - .3 Seals: EPDM O-ring
 - .4 Valve shaft: 420 stainless steel
 - .5 Rating: 150 psi @ 73°C
 - .6 Operators: Manual hand lever with spring lock on all valves.
 - .7 Acceptable material: IPEX series FK heavy duty industrial butterfly valve.
- .2 Ball Valves:
 - .1 Valve, body, stem, ball and unions: PVC resin valve body and disc to ASTM D-1784
 - .2 Seats: EPDM
 - .3 Seals: EPDM O-ring
 - .4 Design: full port with quarter turn
 - .5 Rating: 150 psi @ 73°C
 - .6 Operator: T handle equipped with removable spanner device.
 - .7 Acceptable material: IPEX series VK double blocking ball valve

2.3 PVC AIR BALANCING DAMPER

- .1 For use in ventilation systems where PVC process piping is used.
- .2 All PVC internal parts, suitable for use with acids, alkalis, salts, and other corrosive vapors and fumes.

- .3 Rating: min 25 PSI, max 60°C
- .4 Stainless steel locking hardware including a 1/4 turn locking quadrant for permanent position setting.
- .5 Butterfly damper to restrict airflow less than 5% and provide an approximate 95% seal.
- .6 Socket end connections suitable for use with schedule 40 PVC piping.
- .7 Acceptable material: Plastec Adjustable Butterfly damper model AD04

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION - GENERAL

- .1 Install in accordance with NPC.
- .2 Install pipe work in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework, supplemented as specified herein.
- .3 Assemble piping using fittings manufactured to ANSI and Standard Council of Canada (SCC) standards.
- .4 Piping supports and hangers in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .5 Install piping parallel and close to walls to conserve headroom and space, and grade as indicated.
- .6 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .7 Provide specified fire stopping systems for piping through fire rated walls and floors where required.

3.3 INSTALLATION - PIPING

- .1 Follow piping manufacturers recommendations and directions for all PVC piping installation.
- .2 All PVC piping layout, fitting and joints to be completed at a minimum temperature of 15degC regardless of primer and cement temperature ranges.
- .3 All piping is to be protected from direct sunlight and cold conditions prior to layout, fitting and completion of joints. Piping surface temperatures to be approximately equal to surrounding space temperature.
- .4 Specified cements and primers are recommended general duty only. Where conditions or piping requires cements and primers that vary from the specified products obtain direction from the Engineer prior to proceeding. All fittings to be completed with solvent based cements manufactured in accordance with ASTM D 2456.
- .5 Complete all joints to the recommended practices for making solvent cemented joints described in ASTM D2885.
- .6 Standard of practice for handling of primers and cements shall be in accordance with ASTM F402.

- .7 Ends of pipe to be cut square and beveled to 15-degree chamfer to allow cement flow, all dirt, grease and gloss finish removed.
- .8 All joint ends of pipe and sockets to be primed with approved piping primer prior to solvent cementing.
- .9 Apply solvent cement with manufacturer recommended applicators only.
- .10 Apply cement only after piping has been correctly primed and while primer is still wet.
- .11 While inserting solvent cement joints ensure minimum 1/8 turn to a recommended 1/4 turn of pipe relative to fitting. Provide mechanical devices as required.
- .12 Secure fitted joint for minimum 30 seconds to eliminate pushout. Provide mechanical devices as required.
- .13 Cure all joints to manufacturers recommendations.
- .14 Do not handle joints during initial set time.

3.4 TESTING

- .1 Test system in accordance with Section 23 05 02 - Pipework Testing supplemented as specified herein.

3.5 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 03 30 00 - Cast-in-Place Concrete.
- .3 Section 22 11 16 - Domestic Water Piping.
- .4 Section 23 05 21 - Thermometers and Pressure Gauges - Piping Systems.
- .5 Section 23 07 16 - HVAC Equipment Insulation
- .6 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
- .7 Section 23 08 13 - Performance Verification of HVAC Systems

1.2 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA B51-03 (R2007), Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CAN/CSA C22.2 No.110-94 (R2004), Construction and Test of Electric Storage Tank Water Heaters.
 - .3 CAN/CSA-C191-04, Performance of Electric Storage Tank Water Heaters for Household Service.
 - .4 CAN/CSA-C309-M90 (R2003), Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.
- .2 National Research Council Canada (NRC)
 - .1 National Plumbing Code of Canada 2020 (NPC).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for domestic water heater, and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse or recycling of packaging materials, pallets, padding, and crates in accordance with Section 01 00 10 - General Requirements

1.6 WARRANTY

- .1 For the Work of this Section 22 30 05 - Domestic Water Heaters, 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to number of years specified for each product.
- .2 Contractor hereby warrants domestic water heaters in accordance with CCDC2, but for number of years specified for each product.

Part 2 Products

2.1 ELECTRIC WATER HEATER

- .1 General: Light duty commercial electric, glass-lined storage tank with immersion type heating elements.
- .2 Approvals: ASME, NSF and UL approved. To CAN/CSA C22.2 No.110, CAN/CSA-C191 and CAN/CSA-C309.
- .3 Tank: steel, glass lined with alkaline borosilicate fused to steel by firing at temperature of 871degC.
- .4 Rated pressure: 1034kPa.
- .5 Cathodic protection: extruded magnesium anode
- .6 Jacket: steel, backed enamel finish.
- .7 Insulation: foam insulation to exceed requirements of latest edition of ASHRAE90.1.
- .8 Elements: heat duty medium watt density, incoloy sheathing and pre wired leads.
- .9 Thermostat: immersion type, close differential with control range 35degC to 82degC.
- .10 Control circuit: fused transformer.
- .11 Contactors: heat duty UL rated, 100 000 cycle rated.
- .12 Control cabinet: hinged, house 120v control circuit transformer, transformer fusing, magnetic contactor(s), thermostats, high limit thermostats, element fusing to NEC and elements with pre wired terminal leads.
- .13 Acceptable material: See schedule

2.2 TRIM AND INSTRUMENTATION

- .1 Drain valve: 20mmØ with hose end as per Section 22 11 16 - Domestic Water Piping.
- .2 Thermometer: 100 mm dial type with red pointer and thermowell filled with conductive paste.
- .3 Pressure gauge: 75 mm dial type with red pointer, siphon, and shut-off cock, as per Section 23 05 21 - Thermometers and Pressure Gauges - Piping Systems.
- .4 Thermowell filled with conductive paste for control valve temperature sensor.
- .5 ASME rated temperature and pressure relief valve sized for full capacity of heater, having discharge terminating over floor drain and visible to operators.
- .6 Magnesium anodes adequate for 20 years of operation and located for easy replacement.

2.3 ANCHOR BOLTS AND TEMPLATES

- .1 Supply anchor bolts and templates for installation in concrete support pad in accordance with Section 03 30 00 - Cast-in-Place Concrete.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations and authority having jurisdiction.
- .2 Install drip pan below DHWH per NPCC latest edition. Pipe to floor drain where available or to nearby sanitary / sanitary vent piping complete with an indirect connection.
- .3 Locate tank to ensure adequate clearance for servicing.
- .4 Provide unions or flanges on all connections.
- .5 Install safety relief valve and pipe discharge to floor drain.
- .6 Seismically secure DHW tanks in accordance with Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment

3.3 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-B45 Series-02(R2013), Plumbing Fixtures.
 - .2 CAN/CSA-B125.3-12, Plumbing Fittings.
 - .3 CAN/CSA-B651-12, Accessible Design for the Built Environment.
- .2 National Research Council Canada (NRC)
 - .1 National Building Code of Canada 2020 (NBC).
 - .2 National Plumbing Code of Canada 2020 (NPC).
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-2013, Commercial Adhesives.
- .4 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2011, Adhesive and Sealant Applications.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 **Product Data:**
 - .1 Provide shop drawings including manufacturer's printed product literature and datasheets for commercial fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Indicate fixtures and trim:
 - .1 Dimensions, construction details, roughing-in dimensions.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data in accordance with Section 01 00 10 - General Requirements
- .2 include:
 - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
 - .2 Details of operation, servicing, maintenance.
 - .3 List of recommended spare parts.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect specified materials from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of packaging materials, crates, pallets, and padding, as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 LEAD CONTENT

- .1 All plumbing specialties and accessories are to be lead free type where contact will occur with potable water. Low lead type will only be acceptable where it has been demonstrated that lead free items are not available.

2.2 MANUFACTURED UNITS

- .1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.
- .2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.
- .3 Exposed plumbing brass to be chrome plated.
- .4 Number, locations: architectural drawings to govern.
- .5 Fixtures to be product of one manufacturer.
- .6 Trim to be product of one manufacturer.

2.3 MOP SINKS

- .1 MS-1: Floor Mount Service Sink
 - .1 Basin
 - .1 One piece molded stone body, 610 x 610 x 254mm high, 25mm wide shoulders complete with stainless steel bumper guards, and two panel stainless steel wall guard for corner installation, where required, otherwise one panel, panel height 600mm, chrome plated cast brass outlet strainer.
 - .2 Acceptable material: Fiat 2424
 - .2 Faucet:
 - .1 Wall mounted faucet, blade handles, integral stops, pail hook, inline vacuum breaker, 19mm hose end spout, wall brace, 1219 long reinforced hose, and hose hanger bracket.
 - .2 Acceptable material: Fiat
 - .3 Accessories: refer to drawing schedule
 - .4 Schedule: refer to drawings

2.4 STAINLESS STEEL COUNTER-TOP SINKS

- .1 General, sink: self-rimming drop-in, countertop installation with clamps, integral back ledge for faucet mounting, 3-hole 203mm centers, grade 18-10 (Type 304) stainless steel, 18ga, undercoated.
- .2 General, faucet: deck mount, 3-hole, 203mm centers, chrome plated, cast brass, lead free with ceramic pressure balancing mixing cartridge, single metal lever handle, swivel spout, 5.7 L/min flow aerator. Temperature limiting lever stops.
- .3 Schedule: see drawings
- .4 Fixture Supplies:
 - .1 Polished chrome plated, 10mm IPS brass, flexible risers, escutcheons, loose key ball valve stops, 125mm chrome plated sweat extension.
 - .2 Acceptable material: McGuire H170LK.
- .5 Waste:
 - .1 Cast brass, polished chrome, with clean out and escutcheon, 38dia
 - .2 Acceptable material: McGuire 8912C.

2.5 HAND WASHING SINKS

- .1 HS-1 (Barrier Free): Double station wall hung hand washing sink
 - .1 Wall hung sink, 16 gauge type 304 stainless steel with polished #4 satin finish, with 203 mm (8") high backsplash, without faucet ledge, radius coved bowl corners and rolled radius rim, center waste location, 38 mm (1-1/2") brass tailpiece, standpipe with guard, 89 mm (3-1/2") crumb cup strainer.
 - .2 Backsplash drilled for two faucets, faucets per item below.
 - .3 Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant
 - .4 Overall Dimension: 914 mm (36") long, 457 mm (18") wide, 406 mm (16") high
Bowl Dimension: 851 mm (33-1/2") long, 375 mm (14-3/4") wide, 203 mm (8") deep
 - .5 Acceptable material: refer to drawings
- .2 HS-2 (Barrier Free): Single station wall hung hand washing sink
 - .1 Wall hung sink, 16 gauge type 304 stainless steel with polished #4 satin finish, with 203 mm (8") high backsplash drilled for 102mm (4") centerset faucet, without faucet ledge, radius coved bowl corners and rolled radius rim, rear center waste location, 38 mm (1-1/2") waste
 - .2 Backsplash drilled for one faucet, faucet per item below.
 - .3 Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant
 - .4 Overall Dimensions: 432 mm (17") long, 413 mm (16-1/4") wide, 356 mm (14") high
Bowl Dimensions: 356 mm (14") long, 305 mm (12") wide, 152 mm (6") deep
 - .5 Acceptable material: refer to drawings
- .3 Faucet:
 - .1 Wall-hung mounted, two handles, sink faucet, Chrome-plated finish, 102 mm (4") centerset, lead Free ANSI/NSF 61 compliant, ECAST brass construction

- .2 Vandal-resistant pressure compensating non-aerated spray outlet, 1.9 LPM (0.5 GPM) maximum flowrate, 254mm (10") high gooseneck spout with 133 mm (5-1/4") spout reach
- .3 Vandal-resistant 102 mm (4") wrist blade handles with indexed buttons, quarter turn operation, 13 mm (1/2") NPT (M) connections
- .4 Acceptable material: refer to drawings
- .4 Fixture Supplies:
 - .1 Polished chrome plated, 10mm IPS brass, flexible risers, escutcheons, loose key ball valve stops, 125mm chrome plated sweat extension.
 - .2 Acceptable material: McGuire H170LK.
- .5 Waste:
 - .1 Heavy cast brass, adjustable p-trap, 292 mm (11-1/2") length, with cleanout plug, Steel box flange, neoprene gasket, seamless tubular brass bend, slipnuts
 - .2 Acceptable material: McGuire 8912CB.
- .6 Urinal Wall carrier:
 - .1 Concealed arm with support to floor
 - .2 Acceptable material: refer to drawings

2.6 LABORATORY SINKS

- .1 General: Self-rimming drop-in sink with faucet ledge, 18 gauge type 316 stainless steel polished to #4 satin finish, factory installed hold-down fasteners, factory applied rim seal, center waste location with 38 mm (1-1/2") type 316 stainless steel tailpiece and 89 mm (3-1/2") type 316 stainless steel crumb cup strainer, undercoated to reduce condensation and resonance.
- .2 LS-1: Dry Lab Sink
 - .1 Sink
 - .1 Back ledge drilled for one single hole faucet per faucet below.
 - .2 Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant
 - .3 Overall Dimension: 511 mm (20-1/8") long, 522 mm (20-9/16") wide, 254 mm (10") high.
Bowl Dimension: 457 mm (18") long, 406 mm (16") wide, 254 mm (10") deep.
 - .4 Acceptable material: refer to drawings
 - .2 Faucet: Hot/Cold Domestic Water per item below with rigid gooseneck.
 - .3 Acid neutralizer: Refer to Section 22 05 15 - Plumbing Specialties and Accessories
- .3 LS-2: Chemistry Lab Sink
 - .1 Sink
 - .1 Back ledge drilled for one single hole faucet per faucet below.
 - .2 Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant

- .3 Overall Dimension: 511 mm (20-1/8") long, 522 mm (20-9/16") wide, 254 mm (10") high.
Bowl Dimension: 457 mm (18") long, 406 mm (16") wide, 254 mm (10") deep.
- .4 Acceptable material: refer to drawings
- .2 Faucet: Hot/Cold Domestic Water per item below with rigid gooseneck.
- .3 Acid neutralizer: Refer to Section 22 05 15 - Plumbing Specialties and Accessories
- .4 LS-3: Biology Lab Sink
 - .1 Sink
 - .1 Back ledge drilled for one single hole faucet per faucet below.
 - .2 Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant
 - .3 Overall Dimension: 587 mm (23-1/86") long, 529 mm (20-3/16") wide, 203 mm (8") high.
Bowl Dimension: 533 mm (21") long, 406 mm (16") wide, 203 mm (8") deep.
 - .4 Acceptable material: refer to drawings
 - .2 Faucet: Hot/Cold Domestic Water per item below with rigid gooseneck.
 - .3 Acid neutralizer: Refer to Section 22 05 15 - Plumbing Specialties and Accessories
- .5 LS-4: Prep Room / Instructor's Sink
 - .1 Sink
 - .1 Back ledge drilled for two single hole faucets per faucet below.
 - .2 Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant
 - .3 Overall Dimension: 511 mm (20-1/8") long, 522 mm (20-9/16") wide, 254 mm (10") high.
Bowl Dimension: 457 mm (18") long, 406 mm (16") wide, 254 mm (10") deep.
 - .4 Acceptable material: refer to drawings
 - .2 Faucet:
 - .1 Hot/Cold Domestic Water per item below with swing gooseneck located in center of faucet ledge
 - .2 Reverse Osmosis Water per item below with swing gooseneck located on right corner of faucet ledge
 - .3 Acid neutralizer: Refer to Section 22 05 15 - Plumbing Specialties and Accessories
- .6 Faucets
 - .1 Faucet - Hot/Cold Domestic Water
 - .1 ADA compliant laboratory service faucet
 - .2 Application: Deck mounted mixing faucet with vacuum breaker and wrist blade handles for hot and cold water, polished chrome plated finish.

- .3 Body: Forged brass.
- .4 Valve Units: WaterSaver self-contained compression valve units with replaceable stainless steel seats, ceramic discs
- .5 Handles: 100mm forged brass wrist blade handles with color-coded index discs, red for domestic hot water and blue for domestic cold water with white letters
- .6 Gooseneck: 6" gooseneck, rigid or swing as required.
- .7 Vacuum Breaker: Integral vacuum breaker to prevent backflow, vacuum breaker has replaceable seat and ultra-light float cup to resist spilling at low flow.
- .8 Inlet: 1-3/16" male shank with (2) 3/8" OD flexible copper tubes. Furnished complete with locknut and washer.
- .9 Outlet: 3/8" NPS female outlet with removable anti-splash serration hose end.
- .10 Acceptable material: refer to drawings
- .2 Faucet - Reverse Osmosis Water
 - .1 Same requirements as Faucet - Hot/Cold Domestic Water above except as follows.
 - .2 Handles: 100mm forged brass wrist blade handle with color-coded index disc, white with black letters for reverse osmosis water.
 - .3 Inlet: 3/8" IPS mounting shank with locknut and washer, with a 3/8" NPT male inlet.
 - .4 Acceptable material: refer to drawings
- .7 Fixture Supplies:
 - .1 Polished chrome plated, 10mm IPS brass, flexible risers, escutcheons, loose key ball valve stops, 125mm chrome plated sweat extension.
 - .2 Acceptable material: McGuire H170LK.
- .8 Waste:
 - .1 Sinks with an acid neutralizer:
 - .1 Refer to Section 22 13 18 - Drainage Waster and Vent Piping - Plastic, clause 2.3 Acid Resistant Piping.
 - .2 Acceptable material: Watts Orion Blueline FRPP
 - .2 Sinks without an acid neutralizer:
 - .1 Cast brass, polished chrome, with clean out and escutcheon, 38dia
 - .2 Acceptable material: McGuire 8912C.

2.7 DRINKING FOUNTAIN

- .1 General: Surface mounted, vandal resistant, single level, barrier free, non-filtered, non-refrigerated.
- .2 Cabinet and bowl construction: stainless steel
- .3 Bubbler: vandal resistant, laminar flow, mechanical front bubbler button
- .4 Bottle filler: laminar flow, electronic fill button

- .5 Approvals & Certifications: UL 399, CAN/CSA C22.2 No. 120, lead-free design certified to NSF/ANSI 61 & 372 (lead free).
- .6 Filtered: none
- .7 Cooling: non-refrigerated
- .8 Warranty: 5 year limited on refrigeration system, 1 year of on remainder from substantial.
- .9 Schedule: see drawings
- .10 Acceptable material: Elkay ezH2O Bottle Fill Station with Single ADA Bubbler
- .11 Fixture Supplies:
 - .1 Polished chrome plated, 10mm IPS brass, flexible risers, escutcheons, loose key ball valve stops, 125mm chrome plated sweat extension.
 - .2 Acceptable material: McGuire H170LK.
- .12 Waste:
 - .1 Cast brass, polished chrome, with clean out and escutcheon, 32dia
 - .2 Acceptable material: McGuire 8912C.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Mounting heights:
 - .1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified.
 - .2 Wall-hung fixtures: as indicated, measured from finished floor.
 - .3 Physically handicapped: to comply with most stringent of either NBCC or CAN/CSA-B651.
 - .4 Fixtures shall be service as follows. Sizes are minimum:
 - .1 Refer to drawing schedule.

3.3 ADJUSTING

- .1 Conform to water conservation requirements specified this section.
- .2 Adjustments:
 - .1 Adjust water flow rate to design flow rates.
 - .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
- .3 Checks:
 - .1 Aerators: operation, cleanliness.
 - .2 Vacuum breakers, backflow preventers: operation under all conditions.
- .4 Thermostatic controls:
 - .1 Verify temperature settings, operation of control, limit and safety controls.

3.4 **CLEANING**

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-B45 Series-02(R2013), Plumbing Fixtures.
 - .2 CAN/CSA-B125.3-12, Plumbing Fittings.
 - .3 CAN/CSA-B651-12, Accessible Design for the Built Environment.
- .2 National Research Council Canada (NRC)
 - .1 National Building Code of Canada 2020 (NBC).
 - .2 National Plumbing Code of Canada 2020 (NPC).
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-2013, Commercial Adhesives.
- .4 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2011, Adhesive and Sealant Applications.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data
 - .1 Provide shop drawings including manufacturer's printed product literature and datasheets for washroom fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Indicate fixtures and trim:
 - .1 Dimensions, construction details, roughing-in dimensions.
 - .2 Factory-set water consumption per flush at recommended pressure.
 - .3 (For water closets, urinals): minimum pressure required for flushing.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for washroom fixtures, for incorporation into manual specified in Section 01 00 10 - General Requirements
- .2 Include:
 - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
 - .2 Details of operation, servicing, maintenance.
 - .3 List of recommended spare parts.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect specified materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of packaging materials, crates, pallets, and padding, as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 LEAD CONTENT

- .1 All plumbing specialties and accessories are to be lead free type where contact will occur with potable water. Low lead type will only be acceptable where it has been demonstrated that lead free items are not available.

2.2 MANUFACTURED UNITS

- .1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.
- .2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.3.
- .3 Exposed plumbing brass to be chrome plated.
- .4 Number, locations: as per architectural drawings.
- .5 Fixtures in any one location to be product of one manufacturer and of same type.
- .6 Trim in any one location to be product of one manufacturer and of same type.

2.3 WATER CLOSETS

- .1 WC-1 (Regular): Wall-mounted, exposed flush valve, 38 mm top spud ultra-low flush, maximum 4.8 litres/flush.
 - .1 Approvals: ASME A112.19.2 / CSA B45.1 for Vitreous China Fixtures.
 - .2 381 mm high, white vitreous china with EverClean antimicrobial surface which inhibits the growth of stain and odor causing bacteria mold and mildew, wall-mounted, siphon jet flush action, elongated bowl, 54 mm (2-1/8") fully glazed internal trapway, 254x305 water surface area, bolt caps, static load rating of 454 kg.
 - .3 High Efficiency, Low Consumption: Operates in the range of 4.2 Lpf to 6.0 Lpf, meets definition of HET (High Efficiency Toilet) when used with a high efficiency flush valve (1.28 gpf or 1.6 / 1.1 gpf dual flush),
 - .4 Standard of acceptance: see drawings.
- .2 WC-2 (Barrier Free): Wall-mounted, exposed flush valve, 38 mm top spud ultra-low flush, maximum 4.8 litres/flush.
 - .1 ADA compliant.

- .2 Approvals: ASME A112.19.2 / CSA B45.1 for Vitreous China Fixtures.
- .3 381 mm high, white vitreous china with EverClean antimicrobial surface which inhibits the growth of stain and odor causing bacteria mold and mildew, wall-mounted, siphon jet flush action, elongated bowl, 54 mm (2-1/8") fully glazed internal trapway, 254x305 water surface area, bolt caps, static load rating of 454 kg.
- .4 High Efficiency, Low Consumption: Operates in the range of 4.2 Lpf to 6.0 Lpf, meets definition of HET (High Efficiency Toilet) when used with a high efficiency flush valve (1.28 gpf or 1.6 / 1.1 gpf dual flush),
- .5 Standard of acceptance: see drawings.
- .3 Electronic Water Closet Flush Valves:
 - .1 Barrier free, stainless steel, electronic, sensor proximity type, activated by infrared.
 - .2 Sensor: waterproof, with impact-resistant, anti scratch coated plastic lens, sensitivity adjustable from 100 mm to 450 mm.
 - .3 Water conservation: 30 second maximum run time.
 - .4 Controls: interchangeable receptacles for stainless steel sheathed sensor and modular plug-type solenoid connections, single, slow-closing commercial solenoids for 860 kPa, 85 degrees C.
 - .5 Transformer: 120/12 VDC, UL and CSA listed, box type, sized for up to 8 solenoids.
 - .6 Equipped with manual override button.
 - .7 Acceptable Material: see drawings
- .4 Wall hanger:
 - .1 Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load
 - .2 Required minimum space for installation: 292 mm
 - .3 Industry Standard Horizontal adjustable Closet Carrier single w/Aux inlet, compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, plated hardware, neoprene bowl gasket, adjustable ABS nipple, integral test cap, 51 mm (2") no hub vent connections, 102 mm (4") no hub waste, adjustable for standard and wheelchair height, chrome cap nuts.
 - .4 Acceptable Material: see drawings
- .5 Water Closet Seats:
 - .1 Seat: white, elongated, open front, moulded solid plastic, stainless steel check hinges, stainless steel insert post.
 - .2 Provide with seat cover for Barrier-Free only.
 - .3 Acceptable Material: see drawings
- .6 Water Closet Back Rest:
 - .1 Wall mounting, back rest, solid core plastic laminate panel back, antique white, 12" (305 mm), 4" (102 mm), 8" (204 mm), 18 gauge stainless steel bar with #4 gloss with flanges and covers, concealed snap flanges and mounting hardware

included, Provide adequate backing in wall for support and comply to local codes for barrier free requirements.

- .2 Acceptable Material: see drawings

2.4 URINALS

- .1 UR-1 : wall mounted, ultra-low flush, exposed flush valve, top spud.
 - .1 Urinal: white vitreous china, wall hung, high efficiency 0.5 Lpf, wash down action, flushing rim, 19 mm dia. top spud, Elongated rim, Integral P-trap.
 - .2 Acceptable material: refer to drawings
- .2 Urinal Wall carrier:
 - .1 Concealed arm with support to floor
 - .2 Acceptable material: refer to drawings
- .3 Urinal Electronic Flush Valves:
 - .1 Surface mounted, chrome plated, controlled by infra-red occupancy detector, hardwired.
 - .1 Complete with removable filter, 9 second time delay, flush time adjustable from 0-8 seconds, factory set at 4.5 seconds, 0.5 L flush/cycle maximum.
 - .2 Sensor adjustable from 50-1220 mm, factory set to 860 mm.
 - .3 Solenoid valve: 12 VDC slow-closing type for 60 kPa (minimum), 1000 kPa (maximum), 85 degrees C with manual over-ride, adjustable flow control.
 - .4 Transformer: 120/ 18 VAC Class 2, 12 VDC UL and CSA listed, box type.
 - .5 Acceptable Material: refer to drawings
 - .2 Flush valve(s) controlled by programmed timer permitting 24 hour pre-scheduled flushing. Timer set to flush every 6 hours.

2.5 WASHROOM LAVATORIES

- .1 LV-1A/B (Barrier Free): Wall hung trough lavatory
 - .1 Lavatory:
 - .1 Multiple station deck mounted fixtures, one piece 100% solid surface acrylic/resin trough sink, stainless steel wall mounting bracket, less pipe skirt.
 - .1 Each station: Single hole faucet, single hole soap dispenser on right side of faucet, drain hole with drainage funnel, gasket, and screws.
 - .2 LV-1A, 2 position
 - .1 Overall dimensions: 1524 mm (60") long, 610 mm (24") wide, 127 mm (5") high
Bowl Dimensions: 1422 mm (56") long, 406 mm (16") wide, 63.5 mm (2.5") deep
 - .3 LV-1B, 4 position

-
- .1 Overall dimensions: 3048 mm (120") long, 610 mm (24") wide, 127 mm (5") high
Bowl Dimensions: 2946 mm (116") long, 406 mm (16") wide, 63.5 mm (2.5") deep
 - .4 Acceptable material: refer to drawings
 - .2 Faucet: automatic washroom lavatory faucet per item below.
 - .3 Counter-Mounted, automatic, bulk liquid soap dispenser:
 - .1 Dispenser shall be capable of dispensing and adjustable amount (0.4 to 3 ml) of commercially marketed all-purpose bulk liquid hand soaps of various viscosities, non-iodine-based soaps.
 - .2 Spout assembly shall be bright polished chrome plated ABS plastic with integral stem to accommodate up to 2" (50mm) thick counter tops. Portion Control Knob shall allow field adjustment of desired volume of soap dispensed per hand wash.
 - .3 Unit shall be equipped with a top fill oversized funnel shape opening, covered by a 180° rotatable lid with concealed locking mechanism to allow for top filling.
 - .4 Unit shall have LED indicators to show when unit has been activated. Unit shall have IR Sensor located on PC board housed in water-resistant ABS plastic housing. Activation Lens shall allow for defined activation range to eliminate chance of false activation during hand washing. Unit shall be equipped with an Automatic System Flush Button to allow for cleaning and maintenance.
 - .5 Power adapter: 120 AC to DC adapter, UL and CSA listed, sized for up to 4 soap dispensers, complete with daisy chain adapter.
 - .6 Acceptable material: refer to drawings
 - .4 Waste:
 - .1 Heavy cast brass, 292 mm (11-1/2") distance, with cleanout plug, steel box flange, neoprene gasket, slipnuts, 17-gauge seamless tubular wall bend.
 - .2 Acceptable material: McGuire 8872CB
 - .2 LV-2 (Barrier Free): Single wall hung lavatory
 - .1 Lavatory:
 - .1 Wall-hung lavatory, type 304 18 gauge stainless steel with polished #4 satin finish, single hole centerset, single compartment with overflow and faucet ledge, radius coved bowl corners, with backsplash, center back waste location
 - .2 Overall dimensions: 546 mm (21-1/2") long, 532 mm (20-15/16") wide, 302 mm (11-7/8") high
Bowl Dimensions: 368 mm (14-1/2") long, 330 mm (13") wide, 127 mm (5") deep
 - .3 Acceptable material: refer to drawings
 - .2 Faucet: automatic washroom lavatory faucet per item below.
 - .3 Waste:

- .1 Offset lavatory drain, cast brass with chrome-plated finish, polished chrome strainer with 5.5 mmØ holes size, cast brass elbow, 17 gauge 32 mm (1-1/4") Ø tailpiece diameter, 146 mm (5-3/4") offset
- .2 Acceptable material: McGuire 155WC offset drain
- .4 Complete with insulation and PVC jacket on waste and water supplies for ADA compliance.
- .3 Washroom Lavatory Faucet, automatic:
 - .1 Counter mounted, automatic no-touch, hardwired, polished chrome finish, single hole centerset, flexible supply hoses with 10 mm (3/8") compression connections,
 - .2 Multi-laminar spray outlet, 1.9 LPM maximum flowrate, fixed 254mm high spout with 153 mm reach, vandal-resistant spray insert, key housed inside faucet body, integral above deck water supply shut off.
 - .3 Double infrared sensors with automatic setting feature, solenoid housed in removable carrier that includes supply strainer, above deck individual diagnostic indicators for battery life, solenoid condition, and power-up mode, line purge mode with options for off/12/24 hr operation.
 - .4 Power adapter: 120 AC to DC adapter, UL and CSA listed, sized for up to 6 faucets, complete with daisy chain adapter where used for multiple faucets.
- .4 Fixture Supplies:
 - .1 Polished chrome plated, 10mm IPS brass, flexible risers, escutcheons, loose key ball valve stops, 125mm chrome plated sweat extension.
 - .2 Acceptable material: McGuire LFBV170.
- .5 Fixture carriers:
 - .1 Factory manufactured floor-mounted carrier systems for wall-mounted fixtures.
 - .2 Acceptable material:
 - .1 Manufacturer supplied supports
 - .2 Watts fixture carriers

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Connect fixtures complete with supplies and drains, trapped, supported level and square Hot water faucets shall be on left. Fixtures on outside walls to have supplies from floor; other fixtures to be served from wall. Wall hung fixtures to be securely and firmly mounted.
- .2 Mounting heights for wall hung fixtures measured from finished floor:
 - .1 Standard: to comply with manufacturers roughing-in details unless otherwise indicated or specified.
 - .2 Physically handicapped: to comply with most stringent of either NBC or CSA-B651.

- .3 Fixtures shall be serviced as follows. Sizes shown are minimum.

3.3 ADJUSTING

- .1 Conform to water conservation requirements specified this section.
- .2 Adjustments:
- .1 Adjust water flow rate to design flow rates.
 - .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
 - .3 Adjust flush valves to suit actual site conditions.
 - .4 Set controls of automatic flush valves for WCs and urinals to prevent unnecessary flush cycles.
- .3 Checks:
- .1 Water closets, urinals: flushing action.
 - .2 Aerators: operation, cleanliness.
 - .3 Vacuum breakers, backflow preventers: operation under all conditions.
- .4 Thermostatic controls:
- .1 Verify temperature settings, operation of control, limit and safety controls.

3.4 WALL HANGERS

- .1 Install to manufacturers recommendations full concealed.

3.5 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
- .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 00 - Common Work Results for HVAC
- .3 Section 23 05 01 - Use of HVAC Systems During Constuction
- .4 Section 23 05 03 - Mechanical Start-up
- .5 Section 23 33 00 - Air Duct Accessories
- .6 Section 23 41 00 - Particulate Air Filtration

1.2 PAYMENT PROCEDURES FOR TESTING LABORATORY SERVICES

- .1 Engage and pay for services of independent testing laboratory in accordance with Section 01 00 10 - General Requirements

1.3 REFERENCES

- .1 National Air Duct Cleaners Association (NADCA)
 - .1 ACR Standard, 2006 edition: Assessment, Cleaning and Restoration of HVAC Systems.
- .2 North American Insulation Manufacturers Association (NAIMA)
 - .1 NAIMA 2005, Cleaning Fibrous Glass Insulated Duct Systems - Recommended Practices.
- .3 United States Environmental Protection Agency (US EPA)
 - .1 US EPA 1999, 40 CFR Parts 152 and 156.

1.4 DEFINITIONS

- .1 HVAC System: complete air duct system from outside air intake louvers to furthest air supply terminal unit and including:
 - .1 Rigid supply and return ductwork;
 - .2 Flexible ductwork;
 - .3 Mixing plenum boxes;
 - .4 Return air plenums including ceiling plenums;
 - .5 Cooling and heating coils and compartments;
 - .6 Condensate drain pans, eliminator blades and humidifiers;
 - .7 Fans, fan blades and fan housing;
 - .8 Filter housing and frames;
 - .9 Acoustically insulated duct linings;
 - .10 Diffusers, registers and terminal units;
 - .11 Dampers and controls;

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Site Evaluation: conduct site visit 2 weeks before start of work to establish specific co-ordinated video survey and cleaning plan to establish specific co-ordinated video survey

and cleaning plan determining how areas of facility and HVAC systems will be protected during cleaning operations.

- .1 Organize and lay out plan for video survey and identify camera and cleaning apparatus insertion points.
- .2 Ensure plan identifies sequence and schedule of survey and cleaning operations for each individual HVAC system and for complete facility.
 - .1 Take account of elbows, bends, turning vanes, dampers, transitions, take-offs, and other internal features.
- .3 Consultant or their designated representative to review video survey and cleaning plan 1 week minimum prior to start of work.
 - .1 Proceed with survey and cleaning work only after receiving written approval from Consultant.
- .2 Scheduling:
 - .1 Coordinate with the General Contractor and Mechanical Subcontractor regarding acceptable working hours.
 - .2 General Contractor and/or Mechanical Subcontractor may require cleaning to occur outside normal business hours at their discretion and cost.
- .3 Project Co-ordination: assign Project Co-ordinator to oversee air duct cleaning processes.
 - .1 Provide Consultant with contact information of Project Coordinator including: name, telephone number, cell phone number.
- .4 Coordinate with Mechanical Contractor for installation of duct access doors where required for cleaning.
- .5 Damaged or broken equipment and components found during initial testing and inspection will be repaired or replaced by the applicable Contractor.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit video survey and cleaning plan developed during site evaluation.
 - .1 Ensure plan includes sequence of operation, identification of camera and cleaning apparatus insertion points and schedule for work.
- .3 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets for antimicrobial agents and include product characteristics, performance criteria and limitations.
 - .2 Provide two copies of WHMIS SDS in accordance with Section 01 00 10 - General Requirements for antimicrobial agents or coatings.
- .4 Testing Laboratory Services: submit name and address of laboratory engaged for work of this Section.
 - .1 Submit laboratory analysis report of particulate collection indicating:
 - .1 Location of collection;
 - .2 Particulate grade;
 - .3 Particulate size;
 - .4 Percentage concentration of individual particulates in each sample.

- .5 US EPA Registration: submit verification of EPA Registration of antimicrobial agent.
- .6 Submit verification of delivery of hazardous or toxic waste materials to contaminated waste facility, as described in PART 3 - CLEANING - Waste Management.

1.7 CLOSEOUT SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements.
- .2 Post Cleaning Inspection Report: submit 4 copies of Final Inspection Report, including data collected, observations and recommendations as well as following information:
 - .1 Name and address of facility;
 - .2 Name and address of HVAC cleaning contractor;
 - .3 Description of HVAC systems with drawings identifying systems cleaned;
 - .4 Identification scheme for location points in systems that were inspected with accompanying notes describing methods of inspection or tests used;
 - .5 Identification of points where samples were collected and type of analysis used for each collection;
 - .6 Identification of each sample collected;
 - .7 Comments complete with photographs of each sampling location and other observed system features;
 - .8 Identify systems tested, observations, actions taken and recommendations for future maintenance.
- .3 Record post cleaning video survey: submit 2 copies of video survey on USB Drive media, and include on video survey following:
 - .1 Areas tested for particulate analysis or microbial growth evaluation;
 - .2 Areas of special interest and location;
 - .3 Special internal features;
 - .4 Problems such as broken or damaged controls or components;
 - .5 Ensure system tested, locations, observations, actions taken and recommendations are clearly identified in English on video using text or voice over.
- .4 Submit verification of delivery of hazardous or toxic waste materials to contaminated waste facility.

1.8 QUALITY ASSURANCE

- .1 Contractor: verification of membership in NADCA.
- .2 Project Co-ordinator: Air System Cleaning Specialist (ASCS) certified by NADCA on full time basis.

Part 2 Products

2.1 ACCESS DOORS AND PANELS

- .1 Refer to Section 23 33 00 - Air Duct Accessories for requirements as supplemented herein.
- .2 Equipment Access Doors and Panels: construct from same materials as equipment panelling complete with sealing gasket and positive locking device.

- .1 Size access doors and panels in equipment to allow for inspection and cleaning.
- .3 Ductwork Access Doors: construct access doors from 1.27 mm minimum galvanized sheet steel with gasketed seal.
 - .1 Ensure access door is 25 mm greater in every dimension than access opening.
 - .2 Access door size 200 mm x 200 mm minimum.
 - .3 Secure access doors with sheet metal screws on 75 mm centres minimum. Ensure 3 screws per side minimum.
- .4 Access Doors and Panels Acoustic Lining:
 - .1 Install acoustic lining to match existing.
 - .2 Self-adhesive glass fibre tape capable of adhering to both acoustic lining and metal access door or panel materials.
 - .3 Water-based duct sealer for repairing cut acoustic lining.

2.2 ANTIMICROBIAL AGENT

- .1 Use antimicrobial agents registered with US EPA-40 CFR.

2.3 SYSTEM FILTERS

- .1 Supply and install new filters for each HVAC System cleaned.

2.4 AIR DUCT CLEANING EQUIPMENT

- .1 Manually propelled full contact brushes:
 - .1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, equipment and components of HVAC system.
 - .1 Ensure brushes are sized to fit various duct sizes in HVAC system.
 - .2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces to be cleaned.
- .2 Brushes: manually propelled with integrally-mounted motor and or other non-metallic material bristles.
 - .1 Ensure motor has capacity to continue to push brush after bristles are distorted.
 - .2 Replace worn and ineffective brushes when required.

2.5 MULTI-FUNCTIONAL ROBOTIC CLEANING SYSTEM

- .1 Self-propelled remote controlled, wheeled drive equipped with: halogen lights: reciprocating brushes, air supply nozzle.
 - .1 Ensure brushes are specifically manufactured and shaped to fit acoustic lined ducts, equipment and components of HVAC system.
 - .2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces.
 - .3 Replace worn and ineffective brushes when required.
- .2 Camera: pivotal remote control focus and dustproof digital with 480 lines of resolution, capable of storing 4 hours of recorded media.
 - .1 Camera Light: 2 x 20 watt Halogen with dimmer

2.6 HEPA FILTER EVACUATION FAN

- .1 Evacuation Fan: includes fan, HEPA filter, flexible hose and motor capable of maintaining debris and particulates airborne in airstream until they reach evacuation fan and maintaining system under negative pressure.
 - .1 Ensure HEPA filters are clean and maintain evacuation fan and HEPA filter to run efficiently.

2.7 HEPA VACUUM UNIT

- .1 Vacuum Unit: includes vacuum fan, integral HEPA filter, suction hose and vacuum head, capable of maintaining HVAC System debris and particulates airborne in air stream until they reach vacuum unit and maintaining system under negative pressure.
 - .1 Ensure HEPA filters are clean and maintain vacuum unit and HEPA filter to run efficiently.

Part 3 Execution

3.1 PREPARATION

- .1 Close down HVAC system.
- .2 Locate and identify externally visible HVAC system features which may affect cleaning process including:
 - .1 Control devices;
 - .2 Fire and smoke control dampers;
 - .3 Balancing dampers: indicate and record positions for resetting;
 - .4 Air volume control boxes: indicate and record positions for resetting;
 - .5 Fire alarm devices;
 - .6 Monitoring devices and controls;
- .3 Cut openings in equipment panels and ductwork for access to system interior.
 - .1 Square or rectangular opening sizes: 200 mm minimum each side.
 - .2 Circular opening sizes: 200 mm minimum diameter.
- .4 Installation of Access Doors and Panels: install access doors and panels for equipment where required to facilitate system inspection and cleaning.
 - .1 Install access doors and panels for inspection and cleaning of equipment as follows:
 - .1 Heating and cooling coils;
 - .2 Fan units;
 - .3 Filters;
 - .4 Dampers;
 - .5 Sensors;
- .5 Installation of Access Doors in Ductwork: install access doors in ductwork where required to facilitate system inspection and cleaning.
 - .1 Access door installation is not permitted in flexible ductwork.
 - .1 Inspect flexible ductwork only by disconnecting from main duct and inspecting from open end.

- .6 When acoustically lined duct is cut for access, repair cut edges of acoustic lining using self-adhesive fibre glass tape and water based duct sealer.
 - .1 Adhere new acoustic lining to match existing to inside of access panel or door to ensure continuity of acoustic properties of system.
- .7 Remove and reinstall ceiling panels to gain access to HVAC system as required.
 - .1 Replace ceiling tiles damaged or soiled by air duct cleaning procedures.

3.2 EXAMINATION/PRE-CLEANING INSPECTION

- .1 Verification of Conditions:
 - .1 Make visual inspection of interior of HVAC system using remote controlled robotic camera.
 - .2 Insert camera at pre-established strategic locations to evaluate condition and cleanliness of HVAC systems and components.
- .2 Evaluation and Assessment:
 - .1 Identify location and type of internal components.
 - .2 Identify extent of potential problems.
 - .3 If toxic or hazardous materials or deposits are suspected after initial inspection immediately stop work and inform Consultant.
 - .1 Do not proceed further with inspection operations until written approval from Consultant.

3.3 PARTICULATE COLLECTION

- .1 Before starting duct cleaning, identify locations for sample collection and collect particulate samples.
- .2 Take samples from interior surfaces of HVAC system using sterile wipes for submission to independent testing laboratory.
- .3 For each HVAC system collect 4 samples from each HVAC unit as follows:
 - .1 Sample 1: collect from inside ventilation unit downstream of air filters but before fan discharge;
 - .2 Sample 2: collect downstream of fan discharge and 1 metre maximum downstream in first horizontal branch;
 - .3 Sample 3: collect at junction of last horizontal branch and start of low-pressure duct;
 - .4 Sample 4: collect at junction of nearest and farthest air terminal unit and supply duct.

3.4 LABORATORY ANALYSIS

- .1 Ensure independent testing laboratory has demonstrated experience in work associated with air duct cleaning.
- .2 Ensure Super Electron Microscope (SEM) is used for analyzing and determining components of particulate collection samples:
 - .1 Identify components by grade and size;
 - .2 Report findings including percentage concentration of components to Consultant.

- .3 Proceed with HVAC System Cleaning only after laboratory analysis test results have been received.
- .4 Ensure cleaning technicians have safety equipment appropriate for toxic or hazardous conditions identified by laboratory analysis before proceeding with cleaning operations.

3.5 DUCT CLEANING

- .1 Do duct cleaning in accordance with NADCA ACR Standard.
- .2 Isolate and clean sections in zones to ensure that dirt deposits and debris from zone being cleaned does not pass through another zones which has already been cleaned.
 - .1 Isolate zone of duct using closed-cell polyurethane foam before cleaning.
- .3 Ensure vacuum units and evacuation fans are securely in place before starting cleaning operation of isolated section of HVAC air duct system.
- .4 Install HEPA filter evacuation fan at one end of zone section and insert full contact brushes at other end.
- .5 Clean HVAC supply air duct system and components where particulate sample collected from surfaces is greater than 75 mg of particulate per 0.01 square metres.
- .6 Clean exhaust, return, transfer ductwork and plenums, equipment and components where particulate sample collected from surfaces is greater than 75 mg of particulate per 0.01 square metres.
- .7 Energize brushes to travel from insertion point to HEPA filter evacuation fan.
 - .1 Pass brushes through sections as often as necessary to achieve required cleanliness.
 - .2 Change brush sizes as required to ensure positive contact with duct and component interiors.
 - .3 Clean corners and pockets where dirt and debris can accumulate.
- .8 Clean equipment, components and other features in isolated zone before moving to next zone of HVAC air duct system.
- .9 Clean diffusers, registers, louvers, and other terminal units.
- .10 Remove perforated supply diffusers from suspended tee-bar ceiling.
 - .1 Dismantle and clean perforated plates and supply diffuser duct collars.
 - .2 Re-assemble perforated plate diffusers and reconnect to HVAC system using supply diffuser duct collar after cleaning.
- .11 Advise Generator Contractor, Owner, Consultant 24 hours minimum before deactivation of fire alarm and smoke detectors duct cleaning operations.
 - .1 General Contractor will pay for costs of deactivation of fire alarm and smoke detector system.

3.6 ACOUSTICALLY LINED DUCTWORK CLEANING

- .1 Clean glass fibre acoustically insulated ducts to NAIMA recommended practices.
 - .1 Use specifically designed robotic apparatus that has been demonstrated not to damage acoustic glass fibre lining.
 - .2 Monitor cleaning process progress by onboard camera.

3.7 COMPONENTS AND EQUIPMENT CLEANING

- .1 Brush and vacuum coils, humidifiers, air handling unit enclosures, and heat exchanger surfaces to achieve required cleanliness.
- .2 When cleaning equipment and components by brushing and vacuuming is inappropriate or insufficient, dismantle and remove equipment or component and move to area designated by Consultant for cleaning.
 - .1 Pressure wash with water and cleaning solution until required cleanliness is achieved.
 - .2 Clean equipment and components in place only if there is no hazard to adjacent materials.
- .3 Proceed to next section in cleaning sequence only after written approval from Consultant.
- .4 Compressed air and manual cleaning is acceptable only for cleaning individual components and small areas as follows and only after written approval from Consultant :
 - .1 Fan blades;
 - .2 Dampers;
 - .3 Turning vanes;
 - .4 Controls;
 - .5 Sensor bulbs;
 - .6 Fire alarms;
 - .7 Smoke detectors;

3.8 ANTI MICROBIAL APPLICATION

- .1 Apply antimicrobial agents when fungal growth is suspected.
- .2 Apply antimicrobial agents after removal of surface deposits and debris.
 - .1 Verify air duct interiors are free from deposits and debris by visual inspection.
 - .2 Report findings to Consultant.
 - .3 Proceed with application of antimicrobial agents after written approval from Consultant
- .3 Apply antimicrobial agents in accordance with manufacturer's written instructions and US EPA 40 CFR registration and listing.
- .4 Manual or Robotic spray antimicrobial agents directly onto interior surfaces of HVAC air duct system.
 - .1 Do not use fog mist for downstream surfaces.

3.9 FIELD QUALITY CONTROL/FINAL INSPECTIONS

- .1 Post Cleaning Inspection: carry out final inspection using robotic camera and other visual inspection methods after final cleaning has been completed.
 - .1 Carry out video survey as directed by Consultant.
 - .2 Include in final survey areas inspected by Consultant prior to cleaning.
 - .3 Identify on HVAC system record drawings access points used for inspection and cleaning.

- .4 Re-collect and analyse particulates collected at same locations where original samples were collected before cleaning.
- .5 Reset components including dampers and sensors, which have been disturbed during cleaning operations.

3.10 SYSTEM STARTUP

- .1 Install new system filters after cleaning operations are completed.
- .2 Cover each inspection opening with access door or panel and secure in place after inspection and cleaning are completed.
- .3 Restart each HVAC system.

3.11 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
- .2 Waste Management: separate waste materials for reuse in accordance with Section 01 00 10 - General Requirements
 - .1 Dispose of hazardous or toxic waste materials extracted from ductwork system to appropriate contaminated waste facility and provide proof.
 - .2 Dispose of existing HVAC filter materials to appropriate contaminated waste facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 01 91 13.13 - Commissioning Plan
- .3 Section 01 91 13.16 - Commissioning Forms
- .4 Section 01 91 14 - Facility Commissioning Mechanical
- .5 Section 01 91 15 - Facility Commissioning Electrical
- .6 Section 09 91 00 - Painting.
- .7 Section 23 05 01 - Use of HVAC Systems During Construction
- .8 Section 23 05 02 - Pipework Testing
- .9 Section 23 05 03 - Mechanical Start-Up
- .10 Section 23 05 13 - Common Motor Requirements for HVAC Equipment
- .11 Section 23 05 48 - Vibration and Seismic Controls for HVAC
- .12 Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .13 Section 23 05 53 - Identification for HVAC Piping and Equipment
- .14 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .15 Section 23 08 16 - Cleaning and Start-up of HVAC Piping Systems
- .16 Section 25 05 01 - EMCS: General Requirements

1.2 ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

- .1 For additional acronyms, abbreviations, and definitions used in these specifications, refer to:
 - .1 Section 22 05 00 - Common Work Results for Plumbing
 - .2 Section 25 05 01 - EMCS: General Requirements
 - .3 Section 26 05 00 Common Work Results for Electrical
- .2 The following is a list of acronyms and abbreviations used in these specifications.

HW	Heating Water
HWS	Heating Water Supply
HWR	Heating Water Return
GL	GLycol Water
GLS	GLycol heating water Supply
GLR	GLycol heating water Return
CHW	CHilled Water
CHWS	CHilled Water Supply
CHWR	CHilled Water Return
EAT	Entering Air Temperature
LAT	Leaving Air Temperature
EWT	Entering Water Temperature
LWT	Leaving Water Temperature
OA or O/A	Outside Air
SA or S/A	Supply Air
SA(E) or S/A(E)	Supply Air from ERV-1/2
RA or R/A	Return Air
RA(E) or R/A(E)	Return Air to ERV-1/2
EA or E/A	Exhaust Air
EA(W) or E/A(W)	Exhaust Air - Washrooms
EA(LAB) or E/A(LAB)	Exhaust Air - Laboratory fume hood or extraction arm
EA(CH) or E/A(CH)	Exhaust Air - Laboratory chemical storage cabinets
TA or T/A	Transfer Air
FGE	Flue Gas Economizer

.3 The following is a list of definitions used in these specifications.

.1 Heat exchangers

.1 "Hot side" refers to the side of the heat exchanger where heat is transferred from (the hotter supply temperature).

.2 "Cold side" refers to the side of the heat exchanger where heat is transferred to (the colder supply temperature)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 00 10 - General Requirements

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for all HVAC equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Yukon Territory, Canada.

.2 Indicate on drawings:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.3 Shop drawings and product data accompanied by:

- .1 Detailed drawings of bases, supports, and anchor bolts.
- .2 Acoustical sound power data, where applicable.
- .3 Points of operation on performance curves.
- .4 Manufacturer to certify current model production.
- .5 Certification of compliance to applicable codes.
- .4 In addition to transmittal letter referred to in Section 01 00 10 - General Requirements: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for mechanical equipment and systems for incorporation into manual.
 - .1 Provide 1 complete sets of hard copy and 1 soft copy Operation and Maintenance manual prior to system or equipment tests.
 - .2 Operation and Maintenance manual to be approved by Consultant and Owner, and 4 final hard copies and 1 soft copy deposited with Owner before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .6 Approvals:

- .1 Submit 1 electronic copy of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
- .2 Make changes as required and re-submit as directed by Consultant.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
 - .1 Owner will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows:

AS BUILT DRAWINGS: THIS DRAWING
HAS BEEN REVISED TO SHOW
MECHANICAL SYSTEMS AS INSTALLED

(Signature of Contractor) (Date)
 - .3 Submit to Consultant for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Furnish spare parts as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket set for each heat exchanger.
 - .4 One glass for each gauge glass.
 - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

- .3 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Workplan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of packaging materials pallets, padding, and crates, as specified in Waste Reduction Workplan in accordance with Section 01 00 10 - General Requirements

1.7 MECHANICAL COST BREAKDOWN

- .1 Provide detailed breakdown of Mechanical Sub-Contractor's work prior to first progress claim. Breakdown to be itemized with separate labour and material listing against each item of the contract breakdown. After approval by Consultant cost breakdown will be used as basis for progress payment.
 - .1 Consultant at their sole discretion may allow labor and materials to be combined into a single line item.
- .2 Breakdown and subsequent Progress Claims are to be itemized with separate labour and material listing against each item of the contract breakdown where indicated as required.
- .3 Progress claims will not be reviewed if they do not breakout materials and labour where appropriate.
- .4 Mechanical Contract Breakdown:
 - .1 General
 - .1 Mobilization / Demobilization
 - .2 Administration & Safety
 - .3 Shop drawings
 - .2 Flue Gas Economizer System (items located in the existing Energy Center, Service Tunnels, Academic/Commons wings, and underground)
 - .1 Flue gas economizer package including
 - .1 Economizer
 - .2 Economizer inlet and outlet plenums

-
- .3 Blower, motor, and VFD
 - .4 Chimney high-temperature control dampers and actuators
 - .5 Bypass control valve
 - .6 Control panel with PLC controller, control devices (temperature, pressure, flow meter)
 - .7 Other miscellaneous valves, fittings, and devices as supplied by manufacturer.
- .2 Flue gas ducting (existing boiler chimneys to economizer fan, economizer fan to economizer inlet plenum, economizer outlet plenum to roof penetration)
 - .3 Economizer washdown water connection
 - .4 Emergency heat exchanger
 - .5 Economizer and emergency heat exchanger piping, fittings, and valves
 - .6 Economizer piping, fittings, and valves within the service tunnel and Energy Center
 - .7 Economizer piping, fittings, and valves within the main floor Commons Wing and the upper-level Academics Wing
 - .8 Economizer piping and fittings underground between the Academics Wing and the new building.
 - .9 Economizer piping insulation within the service tunnel and Energy Center
 - .10 Economizer piping insulation within the main floor Commons Wing and the upper-level Academics Wing
- .3 Heating Systems & Equipment
 - .1 Thermal storage tanks
 - .2 Electric boilers
 - .3 Glycol heat exchangers
 - .4 Pumps (economizer, electric boilers, waste heat, secondary, glycol)
 - .5 Tanks (expansion, glycol fill) and major accessories (air/dirt separator, side stream filter, chemical pot feeder)
 - .6 Pre-heat coils and re-heat coils
 - .7 Terminal heating equipment (unit heaters, cabinet unit heaters, convectors)
 - .8 BTU meters
 - .9 Control valves
 - .10 Piping, fittings, and valves
 - .11 Insulation
- .4 Chilled Water Systems & Equipment
 - .1 Chillers
 - .2 Waste heat recovery heat pump
 - .3 Pumps (chiller, secondary, waste heat)
 - .4 Tanks (buffer, expansion, glycol fill) and major accessories (hydraulic separator, side stream filter, chemical pot feeder)

- .5 BTU meters
- .6 Control valves
- .7 Piping, fittings, and valves
- .8 Insulation
- .5 Ventilation Systems & Equipment
 - .1 ERV-1 and 2 (Building ventilation)
 - .2 ERV-3 (Loading / Garbage & Recycling / Storage ventilation)
 - .3 Ducted fume hood exhaust fans and make-up air unit
 - .4 Chemical storage cabinet and fume extraction arm exhaust fans
 - .5 Miscellaneous fans (cooling and exhaust)
 - .6 Fancoils
 - .7 VAV boxes (supply and exhaust)
 - .8 Control dampers
 - .9 Louvers, grilles, diffusers
 - .10 Ductwork
 - .1 ERV-3 O/A, E/A, S/A, and R/A
 - .2 Ducted fume hoods E/A
 - .3 MAU-1 S/A
 - .4 Chemical storage cabinet
 - .5 Fume extraction arm
 - .6 Cooling fans
 - .7 Exhaust fans
 - .8 Fancoils S/A and R/A
 - .9 ERV-1/2 O/A and E/A
 - .11 Insulation
 - .12 Acoustic insulation
- .6 Documentation & Closeout
 - .1 Seismic Restraints
 - .2 Testing and Balancing
 - .3 Performance Verification
 - .4 Commissioning
 - .5 Operation & Maintenance Manuals
 - .6 As-built drawings
 - .7 Training
 - .8 Warranty Review
- .5 Mechanical Controls Contract Breakdown
 - .1 Refer to Section 25 05 01 - EMCS: General Requirements

Part 2 Products - Not Used

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for proper installation in accordance with manufacturer's written instructions.
 - .1 Inform the General Contractor of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation only after unacceptable conditions have been remedied and directed to do so by the General Contractor.

3.2 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 00 - Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.
- .2 Cleaning activities are specified in Section 01 00 10 - General Requirements, however, provide special emphasis on HVAC equipment and duct systems to remove contaminants from the systems prior to operation of any permanent ventilation equipment.

3.4 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 00 10 - General Requirements and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION & TRAINING

- .1 Consultant will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Instruction duration time requirements as specified in appropriate sections as supplemented with minimum training requirements as follows:
 - .1 Division 21 items: refer to Section 21 05 00 - Common Work Results for Fire Suppression
 - .2 Division 22 items: refer to Section 22 05 00 - Common Work Results for Plumbing
 - .3 Division 25 items: refer to Section 25 01 12 - EMCS: Training
 - .4 Flue Gas Economizer: refer to Section 23 57 01 - Flue Gas Economizer for training requirements.
 - .5 Chillers: refer to Section 23 64 00 - Air-Cooled Scroll Water Chillers for training requirements.
 - .6 Waste heat recovery heat pump: refer to Section 23 81 46 - Water Source Unitary Heat Pumps for training requirements.
 - .7 Pumps: refer to Section 23 21 23 - Hydronic Pumps
 - .8 Identification for HVAC Piping and Equipment (including plumbing piping): 15 minutes
 - .9 Overview of Testing, Adjusting and Balancing for HVAC and how to identify balanced position setting: 15 minutes
 - .10 Overview of procedures and materials used for cleaning and start-up of mechanical piping systems: 15 minutes
 - .11 HVAC water treatment (including media testing and monitoring): 1 hour
 - .12 Thermal storage tank, maintenance/inspection and overview of how a thermal storage tank functions: 30 minutes
 - .13 Expansion tanks & glycol fill tanks: 15 minutes
 - .14 Hydraulic separators, air and dirt separators, and air separators (including blowdown where applicable): 15 minutes
 - .15 Dampers - operating: 15 minutes
 - .16 Dampers - fire and smoke: 15 minutes
 - .17 Fans, general: 1 hour
 - .18 Fume hood exhaust fans: 1 hour
 - .19 Single duct terminal units (VAV boxes): 30 minutes
 - .20 Electric heating water boilers: 30 minutes
 - .21 Heat exchangers: 30 minutes
 - .22 Energy Recovery Ventilator - Large: 1 hour
 - .23 Energy Recovery Ventilator - Small: 30 minutes
 - .24 Fancoil units: 1 hour
 - .25 Terminal heating equipment (unit heaters, cabinet unit heaters, convectors): 30 minutes

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 PROTECTION

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Use of Mechanical Systems during construction

1.2 RELATED SECTIONS

- .1 Section 01 00 10 - General Requirements
- .2 Section 22 05 00 - Common Work Results for Plumbing
- .3 Section 23 05 00 - Common Work Results for HVAC

1.3 USE OF SYSTEMS

- .1 Use of new permanent heating, cooling, and ventilating systems for supplying temporary heat or cooling is permitted only under following conditions:
 - .1 Written approval of the Owner and Consultant has been provided.
 - .2 Installation and testing of heating and cooling appliances, pumps, piping and incidentals to facilitate an operational system.
 - .3 Entire system is complete, pressure tested, cleaned, flushed out.
 - .4 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
 - .5 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
 - .6 Permanent installation of all terminal heating and cooling units. Use of temporary heating units is not acceptable.
 - .7 There is no possibility of damage.
 - .8 A temporary filtration system for all appliance burners to a minimum MERV 7 as defined by ASHRAE 52.2.
 - .9 Supply ventilation systems are protected by 60 % filters, inspected daily, changed every week or more frequently as required.
 - .10 Return systems have approved filters over openings, inlets, outlets.
 - .11 Systems will be:
 - .1 Operated as per manufacturer's recommendations and instructions.
 - .2 Operated by Contractor.
 - .3 Monitored continuously by Contractor.
 - .12 Warranties and guarantees are not relaxed and will not begin until substantially complete or as indicated the contract documents and other specifications sections.
 - .13 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Consultant.
 - .14 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.

- .2 Filters specified in this Section are over and above those specified in other Sections of this project.
- .3 Exhaust systems are not included in approvals for temporary heating ventilation.

Part 2 Products - Not Used

Part 3 Execution - Not Used

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 03 - Mechanical Startup
- .3 Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .4 Section 23 05 48 - Vibration and Seismic Controls for HVAC
- .5 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC
- .6 Section 23 08 16 - Cleaning and Start-up of HVAC Piping Systems
- .7 Section 23 25 00 - HVAC Water Treatment

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB).
- .2 National Fire Prevention Association (NFPA).
- .3 National Plumbing Code of Canada (NPC 2020)
- .4 National Fire Code of Canada (NFC 2020)

1.3 GENERAL

- .1 This section covers testing of piping systems and startup of systems common to all sections of Division 21, 22 and 23.

1.4 DEFINITIONS

- .1 Initial Tests:
 - .1 Tests performed prior to final tests to verify general systems integrity. Tests are performed by the Contractor at their discretion
- .2 Final Tests:
 - .1 Mandatory tests performed to confirm system integrity. Final tests to be witnessed by Consultant and Authority having jurisdiction except where specifically noted.

Part 2 Products - Not Used

Part 3 Execution

3.1 NOTIFICATION

- .1 Give 14 days written notice of date and test type for Final Site Tests.
- .2 Provide written notice as per the requirements of Section 01 00 10 - General Requirements
- .3 Written notice to include request for confirmation of witnessing of Final Site Tests by Consultant and Authority having jurisdiction.

3.2 COSTS

- .1 Bear all costs for testing, making good and retesting.
- .2 Final Site Tests are not complete until accepted by Consultant and Authority having jurisdiction. No additional payment shall be made for retesting to meet requirement of these parties for acceptance of tests.

3.3 WITNESSES

- .1 Witnessing of tests by the Consultant and Authority having jurisdiction may be provided by designated Alternates at the discretion of the Consultant or Authority having jurisdiction.

3.4 ACCEPTANCE

- .1 Initial tests are not required to be witnessed or accepted by Consultant or Authority having jurisdiction.
- .2 Final tests are required to be witnessed and accepted by Consultant and Authority having jurisdiction except where otherwise noted. Tests shall be deemed accepted when witnessed and relevant copies of test sheets signed and witnessed by Consultant and Authority having jurisdiction.
- .3 Waiving of Acceptance of Tests: The Consultant and Authority having jurisdiction may waive the requirement of witnessing final site tests. Obtain written verification that Acceptance of Test is waived prior to proceeding with test and append to relevant test certificates.

3.5 TESTING (GENERAL)

- .1 Insulate or conceal work only after testing and approval by Consultant.
- .2 Conduct tests from commencement to finish in presence of Consultant and Authority having jurisdiction or designated Alternate witnesses except where Acceptance of test is waived as per Part 3.4.
- .3 Bear costs including retesting and making good.
- .4 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.
- .5 Check systems during application of test pressure including visual check of leakage of water test medium, soap test for air or nitrogen test medium and halide torch for refrigerant medium.
- .6 When using water as test medium for system not using water or steam, evacuate and dehydrate piping and certify that lines are dry. Use agency specializing in this work.

3.6 PIPEWORK TESTS

- .1 General:
 - .1 Provide the following tests for complete assembled systems
 - .2 Section systems as necessary for all initial tests and test complete system for final tests.
- .2 HVAC Media Piping (Exception Refrigerant):
 - .1 Initial Test: Pneumatic. Acceptable for boarding where heating not available. Test pressure at 413 kPa, minimum 30 min.

- .2 Final Test: Hydraulic. Minimum 860 kPa, minimum 24hrs.
- .3 DWV Piping:
 - .1 Initial test: Provide for sectional ball tests to NPC where directed by Consultant or Authorities having jurisdiction.
 - .2 Final tests: Hydraulic test for all drainage piping with minimum 1.5 m of hydrostatic head for 15 minutes.
- .4 Domestic Water (Rigid Piping):
 - .1 Initial test: Pneumatic. Acceptable for boarding where heating not available. Test pressure not less than 413kPa. Minimum 30 minutes.
 - .2 Final test: Hydraulic. Minimum 860kPa. Minimum 12hrs.
- .5 Domestic Water (PEX Tubing):
 - .1 Initial test: Pneumatic. Acceptable for boarding where heating not available. Test pressure not less than 275kPa. Minimum 30 minutes.
 - .2 Final test: Hydraulic. Minimum 689kPa. Minimum 12hrs.
- .6 Sprinkler and Fire Water Piping
 - .1 Initial test: Pneumatic. Acceptable for boarding where heating not available. Test pressure not less than 40 psi. Minimum 4hrs.
 - .2 Final test(Wet Pipe and Dry Systems):Hydrostatic. In accordance with ANSI/ NFPA 13. Minimum hydrostatic test pressure 200 psi.
 - .3 Final test (Dry Pipe Systems): Pneumatic. In accordance with ANSI/NFPA 13. 40 psi for 24hours. Maximum acceptable leakage 1.5 psi over testing period.
- .7 PVC Process Piping:
 - .1 Pneumatic testing not acceptable for PVC piping.
 - .2 Final test: Hydraulic. Minimum 860kPa. Minimum 12hrs.
- .8 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.

3.7 TEST CERTIFICATES & LOG BOOKS

- .1 General: for each test maintain log book/test certificate.
- .2 All Final Site test logs/sheets to be verified and signed by testing personnel and attending witnesses from Contractor, Consultant or designated alternate and Authority having jurisdiction or designated Alternate.
- .3 Include the following information:
 - .1 Project name and location.
 - .2 System, sub-system or portion of system tested.
 - .3 Time and date.
 - .4 Test pressure and duration of test.
 - .5 Results of test.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 91 13.13 - Commissioning Plan
- .2 Section 01 91 13.16 - Commissioning Forms
- .3 Section 01 91 14 - Facility Commissioning Mechanical
- .4 Section 01 91 15 - Facility Commissioning Electrical
- .5 Section 22 05 15 - Plumbing Specialties and Accessories
- .6 Section 22 10 10 - Plumbing Pumps
- .7 Section 22 30 05 - Domestic Hot Water Heaters
- .8 Section 22 42 02 - Commercial Plumbing Fixtures
- .9 Section 22 42 03 - Commercial Washroom Fixtures
- .10 Section 22 42 13 - Commercial Water Closets, Urinals, and Bidets
- .11 Section 22 42 16 - Commercial Lavatories and Sinks
- .12 Section 22 42 02 - Commercial Showers and Bathtubs
- .13 Section 23 05 02 - Pipework Testing
- .14 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
- .15 Section 23 05 95 - Testing, Adjusting and Balancing.
- .16 Section 23 25 00 - HVAC Water Treatment Systems.
- .17 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC
- .18 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems
- .19 Section 23 21 16 - Hydronic Piping Specialties
- .20 Section 23 21 23 - Hydronic Pumps
- .21 Section 23 25 00 - HVAC Water Treatment
- .22 Section 23 34 00 - HVAC Fans
- .23 Section 23 36 16 - Single Duct Terminal Units
- .24 Section 23 57 00 - Heat Exchangers for HVAC
- .25 Section 23 64 00 - Chillers - Air Cooled
- .26 Section 23 72 00 - Air-To-Air Energy Recovery Equipment
- .27 Section 23 74 00 - Air Handling Units
- .28 Section 23 74 00 - Packaged Outdoor HVAC Equipment
- .29 Section 23 82 19 - Fan Coil Units
- .30 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning

Part 2 Products - Not Used

Part 3 Execution

3.1 START-UP OF MECHANICAL SYSTEMS (GENERAL)

- .1 Prior to any equipment start-up, installation verification must be completed by the contractor using construction checklist developed by or acceptable to the Commissioning Authority in line with the commissioning program. Refer to Commissioning requirements detailed in:
 - .1 Section 01 91 13.13 - Commissioning Plan
 - .2 Section 01 91 13.16 - Commissioning Forms
 - .3 Section 01 91 14 - Facility Commissioning Mechanical
 - .4 Section 01 91 15 - Facility Commissioning Electrical
- .2 Conduct operating startup to confirm that equipment and systems meet specified requirements after mechanical installations are completed and pressure tested and all systems operational. Conduct startup as soon as conditions permit. Make changes, repairs, adjustments and replacements required as tests may indicate prior to final operating tests.
- .3 Startup only after completion of all pressure testing and substantially complete installation of systems.
- .4 During start up advise Consultant in writing of any system deficiencies that are evident and request direction.
- .5 Make start up for a minimum of seven days under maximum available operating load conditions.
- .6 Where seasonal lockout of equipment is specified override seasonal lockout and operate equipment for full seven days of startup.
- .7 Where lead/lag or main/standby staging specified override normal staging to change lead equipment on 24 hour rotation for full seven days of startup.
- .8 Start up to occur in conjunction with Controls Contractor and manufacturer startup and testing.
 - .1 Adequate notice of start-up activities for Commissioning Authority is required. A minimum of 10 business days notice prior to onsite start-up activities is required.
- .9 During startup provide the following operations and maintenance procedures:
 - .1 Lubricate bearings, adjust and/or replace and set direct and V belt drives for proper alignment and tension.
 - .2 Calibrate and adjust thermostats, thermometers, gauges, linkage and dampers. Control valves shall operate freely.
 - .3 Operate and test motors and speed switches for correct wiring and sequences. Check overload heaters in motor starters.

3.2 START-UP OF AIR SYSTEMS

- .1 Startup fans, coil circulators, exhaust air systems and interlocked cooling systems.
- .2 Include for and coordinate manufacturer startup of air handling units, chillers, heat exchangers as specified in:

- .1 Section 23 36 16 - Single Duct Terminal Units
- .2 Section 23 57 00 - Heat Exchangers for HVAC
- .3 Section 23 64 00 - Chillers - Air Cooled
- .4 Section 23 72 00 - Air-To-Air Energy Recovery Equipment
- .5 Section 23 73 00 - Air Handling Units
- .6 Section 23 74 00 - Packaged Outdoor HVAC Equipment
- .7 Section 23 82 19 - Fan Coil Units
- .3 Verify operation of mixing sections, blenders, filters.
- .4 Balance systems in conformance with Section 23 05 95 - Testing, Adjusting and Balancing.
- .5 Complete all fire dampers tests in conformance with Section 23 05 95 - Testing, Adjusting and Balancing.
- .6 Complete acoustic testing in conformance with Section 23 05 95 - Testing, Adjusting and Balancing.
- .7 Operate all air systems at normal operating set points.
- .8 Operate all air systems at normal operating set points.
- .9 Replace and clean filters. Clean fan wheels and coils.

3.3 START-UP OF HYDRONIC SYSTEMS

- .1 Startup pumps, boilers, chillers and all ancillary equipment.
- .2 Complete manufacturer startup of boilers where specified.
- .3 Verify operation of all equipment.
- .4 Balance systems in conformance with Section 23 05 95 - Testing, Adjusting and Balancing.
- .5 Complete all water treatment in conformance with 23 25 00 - HVAC Water Treatment Systems.
- .6 Check system for fluid noise in distribution and pump noise including noise evident of cavitation or pump coupling misalignment.

3.4 START-UP OF DOMESTIC WATER SYSTEMS

- .1 Provide startup of DW systems and equipment specified in Division 22.
- .2 Startup all pumps, hot water heaters, water softeners and ancillary equipment.
- .3 Balance systems in conformance with Section 23 05 95 - Testing, Adjusting and Balancing.
- .4 Complete all flushing and cleaning and disinfection as specified.
- .5 Ensure all water hammer arrestors are installed and functioning. For each fixture or branch system let one outlet run for 10 seconds then shut water off quickly. If hammer occurs, replace arrestor.
- .6 Aerator screens and strainers: clean out.
- .7 Adjust all thermostatic mixing valves to supply maximum 43degC water to plumbing fixtures.

3.5 START-UP OF SANITARY AND STORM WATER SYSTEMS

- .1 Provide startup of SAN and STW systems and equipment specified in Division 22.
- .2 Ensure all traps primed.
- .3 Flush each valve, operate each faucet to ensure drainage and trap anti- siphoning venting is effective.
- .4 Open each cleanout cover and reseal. Ensure all CO are fully accessible.
- .5 Ensure roof drain strainers are installed.
- .6 Verify acid neutralizers are accessible and primed with neutralizing media.

3.6 START-UP OF THERMAL ENERGY METERING SYSTEMS

- .1 Provide start-up of thermal energy meters as specified in section 25 30 02 - Field Control Devices
- .2 Thermal energy meter start-up to be as per manufacturer's start-up and commissioning procedures as outlined in relevant product installation and operation guide.
- .3 Coordinate start-up of thermal energy meters with start-up of EMCS system as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning to ensure communication is established between the meters and EMCS.

3.7 LOG BOOKS

- .1 General: for each system startup maintain log book of startup conditions including the following information:
 - .1 Day.
 - .2 Operating personnel.
 - .3 System status at 0800hrs/1300hrs/1800hrs including the following information:
 - .1 Weather conditions.
 - .2 Equipment set and operating points showing deviation for the following:
 - .1 HW Thermal storage tank temperatures (all gauges/levels)
 - .2 HW Economizer EWT/LWT
 - .3 HW Boiler EWT/LWT
 - .4 Heat recovery heat pump HW and CHW EWT/LWT
 - .5 HW/GL HEX EWT/LWT
 - .6 CHW Chiller EWT/LWT
 - .7 HWS, GLS, CHWS temperature on all circuits.
 - .8 HWR, GLR, CHWR temperature on all circuits.
 - .9 All HW, GL, CHW, DW pump differential pressures.
 - .10 ERV PHC and RHC HWS and HWR temperatures
 - .11 ERV SF and RF Status.
 - .12 ERV Filter Pressure.
 - .13 ERV S/A, R/A, E/A, O/A temperatures
 - .14 ERV HRC Leaving Air temp.
 - .15 ERV O/A and E/A damper status.

- .16 FCU S/A and R/A temperatures
- .17 FCU fan status
- .18 FCU heating/cooling coil CV positions
- .19 FCU / VAV box damper positions
- .20 DW booster pump inlet and outlet pressures
- .21 DHW Heater temp.
- .22 DHWR temp.
- .23 Space conditions minimum 10 heating terminal unit zones per floor.
- .3 All Start Up logs to be verified and signed by testing personnel and attending witnesses from Contractor.
- .4 Use of trend data from control system is acceptable for systems status. Provide relevant print outs in tabular and graphic format.

3.8 BUILDING FLUSH OUT

- .1 Provide for Building flush out as specified herein.
- .2 Maintain a minimum 16°C space air temperature and space relative humidity of 20%.
- .3 Advise Consultant in writing when TAB completed and ventilation systems suitable for building ventilation flush.
- .4 Operate all air systems continuously in conformance to the flush out schedule with final and pre filters in place to flush out the building prior to occupancy. Up to seven of flush-out operational days may be scheduled coincidental with the Building Startup specified in this Section. Operate all exhaust fans interlocked to main Air Systems.
- .5 Flush out schedule:
 - .1 Outdoor air systems: operate system at full design air volume and 100% outdoor air for a minimum of 14 days. All VAV terminal air controllers to be at maximum design set point.
 - .2 Recirculated or mixed air systems:
 - .1 Alternate 1: operate system at full air volume and 100% outdoor air for a minimum of 14 days using economizer option.
 - .2 Alternate 2: Operate system at full air volume and at design outdoor air rate of 25% for a minimum of 40 days.
- .6 Maintain the Startup log book for the full flush out period for the following equipment set and operating points:
 - .1 Start and stop dates and total operating duration
 - .2 AS H/C HWS.
 - .3 AS H/C HWR
 - .4 AS Fan Status
 - .5 AS Filter Pressure
 - .6 AS S/A Temp
 - .7 AS R/A Temp
 - .8 AS E/A Temp

- .9 AS O/A Temp
- .10 AS HRC Leaving Air Temp
- .11 AS O/A damper Status.
- .7 Upon acceptance of the building flush out, replace all filter media with new.
- .8 Submit to the Consultant for approval the following:
 - .1 Startup log books including the following information:
 - .1 Building flush out procedures.
 - .2 Start and stop dates for each air system.
 - .3 Outdoor airflow volumes and durations for each air system.
 - .4 Calculated total volume of flush air.
 - .9 See the following sections for additional requirements:
 - .1 Section 23 05 93 - Testing, Adjusting and Balancing
 - .2 Section 23 36 16 - Single Duct Terminal Units
 - .3 Section 23 72 00 - Air-To-Air Energy Recovery Equipment
 - .4 Section 23 73 00 - Air Handling Units
 - .5 Section 23 82 19 - Fan Coil Units

3.9 SYSTEM TESTS

- .1 Conduct specified system tests in presence of Engineer to confirm that equipment and systems meet specified requirements. Conduct system tests during Interim inspection and only after system startup completed with the exception that system tests may take place during the final day of the Building Startup.
- .2 Where directed by the Consultant make changes, repairs, adjustments and replacements within the scope of these documents as required to allow completion of the system tests.
- .3 Provide all tools and equipment necessary to complete specified tests. Patch and make good any damage created during tests at no additional cost.
- .4 Provide tradespersons as required to complete specified tests for the duration of the one day testing period.
- .5 Provide the following tests to be witnessed by the Consultant:
 - .1 Prove random access to cleanouts at the direction of the Consultant.
 - .2 Prove random access through access doors at the direction of the Consultant.
 - .3 Prove random operation of plumbing fixtures including maximum DHW temperature at high limit protected plumbing fixtures and run time on all spring or metered fixtures.
- .6 Prove operation of all safety systems for the following systems or provide test data from Authority Having Jurisdiction proving successful completion of tests:
 - .1 All DW system backflow preventers
 - .2 All DWH heaters.
 - .3 FGE system
 - .4 HW Electric Boilers
 - .5 CHW Chillers

.6 All ventilation systems.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Electrical motors, drives and guards for mechanical equipment and systems.
 - .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 21, 22 and 23. Refer to Division 26 for quality of materials and workmanship.

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 21 30 00 - Fire Pumps
- .3 Section 22 05 00 - Common Work Results for Plumbing
- .4 Section 22 10 10 - Plumbing Pumps
- .5 Section 23 05 00 - Common Work Results for Mechanical
- .6 Section 23 21 23 - Hydronic Pumps
- .7 Section 23 34 00 - HVAC Fans
- .8 Section 23 64 00 - Air Cooled Scroll Water Chillers
- .9 Section 23 72 00 - Air-To-Air Energy Recovery Equipment
- .10 Section 23 73 00 Air Handling Units
- .11 Section 23 74 00 - Packaged Outdoor HVAC Equipment
- .12 Section 23 82 19 - Fan coil units
- .13 Section 23 82 39 - Unit Heaters

1.3 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 National Energy Code of Canada 2020 (NEC)

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 00 10 - General Requirements. Include product characteristics, performance criteria, and limitations.
- .3 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 00 10 - General Requirements

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 GENERAL

- .1 Motors: high efficiency, in accordance with local electrical power company standards and to ASHRAE 90.1 and NEC.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by Consultant for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motor phase, cycle and voltage are specified within this Division. Coordinate with Division 26 regarding specified or substitute motors. Refer discrepancies to Consultant for review.
- .4 Types:
 - .1 Constant speed: open drip proof, open, TEFC, etc as specified in specific technical sections or as indicated.
 - .2 Variable frequency/speed: TEFC, NEMA MG1-1998 Part 31 suitable for use with VFD.
 - .3 All motors to be high power factor for 0.75kW and larger.
 - .4 All motors to be TEFC for 0.37kW and larger.
- .5 Efficiency:
 - .1 Motors less than 1.2kW: minimum efficiency 85%.
 - .2 Motors 1.2kW to 3.73kW: minimum efficiency 87%.
 - .3 Motors 3.73kW to 7.5kW: minimum efficiency 89%.
 - .4 Motors 7.5kW to 18.7kW: minimum efficiency 92%.
- .6 Shaft Grounding

- .1 Provide shaft grounding assembly for all motors 0.75kW and larger unless otherwise indicated and controlled by Variable Frequency Drive. Shaft grounding device to be in the form of brush that resides on the motor shaft. Brush assembly shall be capable of tolerating misalignment and maintaining rotating contact throughout the motor's life and as follows:
 - .1 Material: Material used in the grounding assembly shall be stable material commonly used within industry that is not believed to constitute a hazardous material under Occupational Safety and Health regulations.
 - .2 Brushes: Specifically developed carbon compounds of sustained performance with wear life expectancy of 3 years minimum.
 - .3 Seals: In wet or severe environment applications, brush contact area shall be of sealed type to keep contaminants from entering the shaft grounding system.
 - .4 Shaft grounding assembly installation shall not affect the motor manufacturer warranty. Where the severe environment conditions require application of the shaft grounding types that are screwed into the motor shaft, the installation of the shaft grounding system shall be performed either by the motor manufacturer or by the motor manufacturer authorized facility.
 - .5 Manufacturer: Shaft grounding Inc. or approved.
- .2 Bond the brush to the closest ground point using code sized green insulated stranded copper conductor per manufacturer instructions.
- .3 Test and verify the performance of the assembly to ensure that under no conditions the shaft voltage exceeds 3 volts.

2.3 VARIABLE FREQUENCY DRIVES (VFDS)

- .1 Separate electronic VFDS shall be provided for each motor where required. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. The VFDS shall be UL listed. The listing shall allow mounting in plenum or other air handling compartments.
- .2 The VFD shall be of the PWM (Pulse Width Modulation) design using up to date IGBT (Insulated Gate Bipolar Transistor) technology.
- .3 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of the motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for fan and/or pump control and to eliminate the need for motor de-rating.
- .4 The VFD shall have, as a standard component, an RFI filter (Radio Frequency Interference) to minimize electrical noise disturbances between the power electronics and the power supply. The VFD/motor shall meet all requirements of the EMC directive concerning residential and light industry equipment (EN 61800-3).
- .5 The VFD shall have a minimum of two skip frequency bands which can be field adjustable.
- .6 The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current.
- .7 The VFD/motor shall include protection against input transients, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature. The

- motor over-temperature protection shall consist of three series connected PTC thermistors, one for each motor phase.
- .8 The VFD/motor shall provide full nameplate output capacity (horsepower and speed) within a balanced voltage range.
 - .9 Automatic De-Rate Function: The VFD/motor shall reduce speed during periods of overload allowing for reduced capacity fan and/or pump operation without complete shut-down of the system. Detection of overload shall be based on continuous monitoring of current, voltage and temperature within the VFD/motor assembly.
 - .10 The VFD shall have, as a minimum, the following input/output capabilities:
 - .1 Speed Reference Signal: 0-10 VDC, 4-20mA.
 - .2 Digital remote on/off.
 - .3 Fault Signal Relay (NC or NO).
 - .4 Communications ports suitable for BACnet interface.
 - .11 All drives shall be factory run tested prior to unit shipment.
 - .12 The drive output shall be controlled by the building HVAC control system and drive status and operating speed shall be monitored and displayed at the building HVAC control system.
 - .1 Air handling unit supply and return fans:
 - .1 The supply and return/exhaust fan drive outputs shall be independently controlled in order to provide the control needed to maintain building pressure control.
 - .2 Supply and return/exhaust air fan drives that are slaved off a common control output are not acceptable.
 - .13 A manual bypass contactor arrangement shall be provided for each VFD. The bypass arrangement will allow the motor to operate at 100% speed even if the drive has been removed for service.
 - .14 Where VFD drives are used for motor 5HP and larger, provide harmonic filters.
 - .15 Acceptable Manufacturers: ABB, Danfoss

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 10 HP: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 10 HP and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.

- .8 Supply one set of spare belts for each set installed in accordance with Section 01 00 10 - General Requirements

2.5 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
 - .1 "U" shaped, minimum 1.6mm thick galvanized mild steel.
 - .2 Securely fasten in place
 - .3 Removable for servicing
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 00 10 - General Requirements
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 22 05 23 - Valves for Plumbing Piping
- .3 Section 22 11 16 - Domestic Water Piping
- .4 Section 22 13 17 - Drainage Waste and Vent Piping - Cast Iron and Copper
- .5 Section 22 13 18 - Drainage Waste and Vent Piping - Plastic
- .6 Section 22 13 19 - PVC Process Piping
- .7 Section 23 05 02 - Pipework Testing
- .8 Section 23 05 03 - Mechanical Start-up.
- .9 Section 23 05 23.01 - Valves - Bronze
- .10 Section 23 05 23.02 - Valves - Cast Iron
- .11 Section 23 05 23.03 - Valves - Cast Steel
- .12 Section 23 05 23.05 - Valves - Butterfly
- .13 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .14 Section 23 05 48 - Vibration and Seismic Controls for HVAC
- .15 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems
- .16 Section 23 21 13.01 - Hydronic Systems: Copper
- .17 Section 23 21 13.02 - Hydronic Systems: Steel
- .18 Section 23 25 00 - HVAC Water Treatment Systems.

1.2 REFERENCE STANDARDS

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.
- .3 National Research Council Canada (NRC)
 - .1 National Fire Code of Canada 2020 (NFC).
- .4 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:

- .1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse or recycling of packaging materials, pallets, crates, and padding in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 MATERIAL

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
 - .1 Paints, Primers and Coatings: Apply in accordance with manufacturer's recommendations for surface conditions.
 - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11.
 - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: maximum VOC limit to GSES GS-36.
- .3 Sealants: maximum VOC limit to GSES GS-36.
- .4 Adhesives: maximum VOC limit to GSES GS-36.
- .5 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 CONNECTIONS TO EQUIPMENT

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.

- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

3.4 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain.
 - .1 Discharge to be visible.
- .4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

- .1 Install manual air vents to vent at high points.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .10 Group piping wherever possible and as indicated.
- .11 Ream pipes, remove scale and other foreign material before assembly.

- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion as indicated.
- .14 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Use ball valves at branch take-offs for isolating purposes except where specified.
 - .6 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .7 Install ball valves for glycol service.
 - .8 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .15 Check Valves:
 - .1 Install silent check valves in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for fire stopping.
 - .2 Maintain the fire-resistance rating integrity of the fire separation.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: one piece type with set screws.
 - .1 Chrome or nickel plated brass or type 302 stainless steel..
- .3 Sizes: outside diameter to cover opening or sleeve.
 - .1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

- .1 Coordinate the installation of fire stopping around pipes, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Pipes subject to movement: conform to fire stop system design listing to ensure pipe movement without damaging fire stopping material or installation.
- .3 Insulated pipes: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 02 - Cleaning and start-up of HVAC piping systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 00 10 - General Requirements supplemented as specified in relevant mechanical sections.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Consultant 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Consultant or their designated representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Consultant.

3.13 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Owner and Consultant.
- .2 Request written approval by Owner and Consultant 14 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.

3.14 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 53 - Identification For HVAC Piping and Equipment.

1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.
- .3 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
 - .1 IPMVP 2007 Version.
- .4 Green Seal Environmental Standards (GS)
 - .1 GS-11-11, Standard for Paints and Coatings.
 - .2 GS-36-11, Standard for Commercial Adhesives.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for thermometers and pressure gauges and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store thermometers and pressure gauges in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect thermometers and pressure gauges from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

- .4 Develop Waste Reduction Workplan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of pallets, padding, crates, and packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 GENERAL

- .1 Design point to be at mid-point of scale or range.
- .2 Ranges: as indicated.

2.2 DIRECT READING THERMOMETERS - LINEAR

- .1 General: industrial variable angle type linear thermometer, direct reading.
- .2 Case: V shape molded Valox
- .3 Bulb chamber: tapered cast aluminum
- .4 Tube & sensing liquid: glass (magnifying) with organic green or red fluid
- .5 Stem length: 100mm-150mm as required for insulation.
- .6 Scale: white coated aluminum with black lettering.
- .7 Lens: flat glass.
- .8 Size: 225mm scale length
- .9 Accuracy: +/-1% of dial scale throughout entire range to CAN/CGSB-14.4-M88.
- .10 Ranges:
 - .1 HW & DW: 0°C to 100°C.
 - .2 CW: -10°C to 50°C.
 - .3 C (condensate): -10°C to 110°C.
 - .4 Duct: -70°C to 70°C.
- .11 Acceptable Material: Weksler A9 series, Winters TIM series

2.3 DIRECT READING THERMOMETERS - ROUND

- .1 General: bi-metal dial type, direct reading.
- .2 Case: hermetically sealed, 304 stainless steel socket with slip ring.
- .3 Helix: silicone dampening of bimetallic element.
- .4 Socket and Stem: 304 stainless steel.
- .5 Stem length: 100mm-150mm as required for insulation.
- .6 Dial: white coated aluminum with black lettering.
- .7 Lens: flat glass.
- .8 Size: 57mm
- .9 Accuracy: +/-1% of dial span throughout entire range to CAN/CGSB-14.4-M88.
- .10 Ranges:

- .1 HW & DW: 0°C to 100°C.
- .2 CW: -10°C to 50°C.
- .3 C (condensate): -10°C to 110°C.
- .4 Duct: -70°C to 70°C.
- .11 Acceptable Material: Marsh/Winters Bi-metal thermometers.

2.4 REMOTE READING THERMOMETERS

- .1 100 mm diameter mercury-free activated dial type: to CAN/CGSB-14.5, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished stainless steel case for wall mounting.

2.5 THERMOMETER WELLS

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass or stainless steel.

2.6 PRESSURE GAUGES

- .1 Dial type to ASME B40.1-2000, self indicating, 2% accuracy and plain case with twist locking ring and recalibration adjustment.
- .2 Bourdon tube: copper alloy tube, tip and socket.
- .3 Dial: steel, white enamel background, black printed labels.
- .4 Lens: flat glass.
- .5 Movement: brass, bronze bushings, stainless steel pinion and arbor.
- .6 Size: 100mm.
- .7 Snubbers: brass body, as required.
- .8 Ranges:
 - .1 HW: 0-413 kPa.
 - .2 DW/CW and C (cond): 0-1100 kPa.
- .9 Acceptable Material: Marsh/Winter, Wika

2.7 GAUGE VALVE

- .1 Class 600, regular port, threaded, bronze body, plated brass ball, brass gland and PTFE Teflon seat, wing handle, screwed.
- .2 Acceptable Material: Kitz, Toyo.

Part 3 Execution

3.1 GENERAL

- .1 Install thermometers and gauges so they can be easily read from floor or platform.
 - .1 If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

- .1 Install in wells on piping. Include heat conductive material inside well.
- .2 Install in locations as indicated on drawings and on inlet and outlet of:
 - .1 Heat exchangers.
 - .2 Heating coils.
 - .3 DHW tanks.
- .3 Install wells as indicated only for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in locations as follows:
 - .1 Suction and discharge of pumps and upstream of pump strainers
 - .2 Upstream and downstream of control valves.
 - .3 Inlet and outlet of coils.
 - .4 Inlet and outlet of heat exchangers on hot and cold side.
 - .5 In other locations as indicated.
- .2 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .3 Use extensions where pressure gauges are installed through insulation.

3.4 NAMEPLATES

- .1 Install engraved lamicoid nameplates in accordance with Section 23 05 53 - Identification For HVAC Piping and Equipment, identifying medium.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by thermometer and gauge installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 15 - Common Installation Requirements for HVAC Pipework

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1-1983 (R2006), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International (ASTM)
 - .1 ASTM A276-08, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-08a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-08a, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2008, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit data for valves specified in this Section.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 00 10 - General Requirements

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
 - .1 Furnish following spare parts:

- .1 Valve seats: one for every 10 valves each size, minimum 1.
- .2 Discs: one for every 10 valves, each size. Minimum 1.
- .3 Stem packing: one for every 10 valves, each size. Minimum 1.
- .4 Valve handles: 2 of each size.
- .5 Gaskets for flanges: one for every 10 flanged joints.
- .2 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse or recycle of crates, packaging materials, padding, and pallets, in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: solder ends to ANSI/ASME B16.18.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .4 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2-1/2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 NPS 2-1/2 and under, swing type, bronze disc:

-
- .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .4 NPS 2-1/2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
 - .5 NPS 2-1/2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
 - .6 NPS 2-1/2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
 - .5 Silent Check Valves:
 - .1 NPS 2-1/2 and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
 - .4 Disc and seat: renewable rotating disc.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.
 - .6 Ball Valves:
 - .1 NPS 2-1/2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125, 860 kPa steam.
 - .3 Pressure rating: Class 600.
 - .4 Connections: solder ends to ANSI.
 - .5 Stem: tamperproof ball drive.
 - .6 Stem packing nut: external to body.
 - .7 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
 - .8 Stem seal: TFE with external packing nut.
 - .9 Operator: removable lever handle.
 - .7 Drain Valves:
 - .1 Minimum 13Ø, class 600, bronze body, full bore, forged brass, ball, brass gland and PTFE Teflon seat, steel lever handle, screwed, male hose end c/w cap and chain.
 - .2 Acceptable Material: Kitz/Toyo
 - .8 Strainers
-

- .1 NPS 2-1/2 and Smaller: Class 150, 1033 kPa, Y-pattern, screwed cap, stainless steel screen, bronze body, screwed.
- .2 Strainers to be line size.
- .3 Acceptable Material: Kitz Fig 15/Toyo.
- .9 Flow Balancing Valve & Measuring Station
 - .1 Hydronic circuit balancing valve c/w pressure differential read-out ports.
 - .2 Shut-off: positive drip proof.
 - .3 Metering ports; 6mmØ NPT brass, nordel check valves and gasketed caps.
 - .4 Drain ports: additional 6mmØ NPT connections with brass plugs.
 - .5 Valve Body: Y pattern, equal percentage globe style.
 - .6 Construction: Y pattern, bronze body, high strength engineered resin plug with precision contoured channels for uniform flow distribution, bronze stem, high strength resin hand wheel and sleeve, minimum 4-360 turns from full open to full closed, hidden memory feature.
 - .7 Insulation jacket: preformed, PVC, to ASTM D 1784/class 14235-C, MEA#7-97, ASTM-E-84 and ASTM-136, flame spread rating 50 or less, insulation to requirements of section 23 07 19 - Thermal Insulation for HVAC piping.
 - .8 Connections: sweat or threaded.
 - .9 Size: as indicated on drawings
 - .10 Acceptable Material: Armstrong CBV-T or CBV-S circuit balancing valves, Tact, T&A, ITT.

Part 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.
- .4 Install to manufacturer's recommendations.
- .5 Maintain proper clearance to permit service and maintenance.
- .6 Should deviations beyond allowable clearances arise, request and follow Engineer's directive.
- .7 Install specified valves at all branch take-offs and as indicated.
- .8 Install flow measuring stations and flow balancing valves at locations as indicated. Provide required straight pipe to manufacturers recommendations.
- .9 Provide silent check valves in vertical pipes with downward flow and as indicated.
- .10 Provide swing check valves on discharge of pumps as indicated.

3.2 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Set security stops to prevent tampering.

- .3 Complete setup tag and hang on valve when TAB is complete.

3.3 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 15 - Common Installation Requirements for HVAC Pipework

1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1-05, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 ASTM International (ASTM).
 - .1 ASTM A49-01 (2006), Standard Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A126-04, Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM A536-84 (2004)e1, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM B85/B85M-08, Standard Specification for Aluminum-Alloy Die Castings.
 - .7 ASTM B209-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-61-03, Pressure Testing of Steel Valves.
 - .2 MSS SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP-71-05, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP-82-1992, Valve Pressure Testing Methods.
 - .5 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for incorporation into manual specified in Section 01 00 10 - General Requirements

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse or recycle of pallets, padding, crates, packaging materials in accordance with Section 01 00 10 - General Requirements

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size, minimum 1.
 - .3 Stem packing: one for every 10 valves, each size, minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
- .3 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.

Part 2 Products

2.1 MATERIAL

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
- .2 Standard specifications:
 - .1 Gate valves: MSS SP-70.
 - .2 Globe valves: MSS SP-85.
 - .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
 - .1 Body, bonnet: ductile iron to ASTM A536 Grade 65-45-12.
 - .2 Connections: flanged ends plain face to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.

- .9 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have CRN registration numbers.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 8, non rising stem, inside screw, iron trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62.
 - .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
 - .4 Stem: bronze to ASTM B62.
 - .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
 - .6 Seat: integral with body.
 - .7 Stem: wrought steel.
 - .8 Operator: handwheel.
 - .9 Bypass: complete with union and NPS ball valve as Section 23 05 23.01 - Valves - Bronze
- .2 NPS 2 1/2-8, outside screw and yoke (OS&Y), iron trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - .3 Seat rings: renewable bronze screwed into body.
 - .4 Stem: nickel-plated steel.
 - .5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - .6 Seat rings: integral with body.
 - .7 Stem: nickel-plated steel.
 - .8 Pressure-lubricated operating mechanism.
 - .9 Operator: handwheel.
 - .10 Bypass: complete with union and NPS ball valve as Section 23 05 23.01 - Valves - Bronze

2.3 UNDERWRITERS APPROVED GATE VALVE

- .1 NPS 2 1/2 - 14, OS&Y:
 - .1 Approvals: UL and FM approved for fire service.
 - .2 UL and FM Label: on valve yoke.
 - .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B).
 - .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.

- .5 Packing gland: bronze.
- .6 Stem: manganese bronze. Diameter to ULC C-262 (B). Brass, ASTM B16.
- .7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
- .8 Bosses for bypass valve, drain: on NPS 4 and over.
- .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: EPDM coated cast iron with bronze disc rings.
- .10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
- .11 Pressure rating:
 - .1 NPS 2-1/2 - 12: 1.7 Mpa CWP.
 - .2 NPS 14-1.2: 1.2 MPa CWP.
- .12 Operator: handwheel.
- .13 Bypass: complete with union and NPS ball valve as Section 23 05 23.01 - Valves - Bronze

2.4 VALVE OPERATORS

- .1 Install valve operators as follows:
 - .1 Handwheel: on valves except as specified.
 - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.

2.5 CHECK VALVES

- .1 Swing check valves, Class 125:
 - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Grooved or flanged ends: plain faced with smooth finish.
 - .1 Up to NPS 16: cast iron to ASTM A126 Class B or ductile iron ASTM A536 Grade 65-45-12.
 - .2 Ratings:
 - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
 - .3 Disc: rotating for extended life.
 - .1 Up to NPS 6: bronze to ASTM B62.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .5 Hinge pin, bushings: renewable bronze to ASTM B62.
 - .6 Disc: A126 Class B, secured to stem, rotating for extended life.
 - .7 Seat: cast iron, integral with body.
 - .8 Hinge pin: exelloy; bushings: malleable iron.
 - .9 Identification tag: fastened to cover.
 - .10 Hinge: stainless steel.
- .2 Swing check valves, NPS 2 1/2 - 8 Class 250:
 - .1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.
 - .2 Flanged ends: 2 mm raised face with serrated finish.

- .3 Rating: 250 psi steam; 500 psi CWP.
- .4 Disc: rotating for extended life.
 - .1 Up to NPS 3: bronze to ASTM B61.
 - .2 NPS 4 - 8: iron faced with ASTM B61 bronze.
- .5 Seat rings: renewable bronze to ASTM B61, screwed into body.
- .6 Hinge pin, bushings: renewable, bronze to ASTM B61.
- .7 Hinge: galvanized malleable iron.
- .8 Identification tag: fastened to cover.

Part 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.

3.2 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 15 - Common Installation Requirements for HVAC Pipework

1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16, Fittings and Valves Package.
 - .2 ASME B16.5-2009, Pipe Flanges and Flanged Fittings: NPS through NPS 24 Metric/Inch Standard.
 - .3 ANSI/ASME B16.10-2009, Face-to-Face and End-to-End Dimensions Valves.
 - .4 ANSI/ASME B16.25-2007, Buttwelding Ends.
 - .5 ANSI/ASME B16.34- 2009, Valves Flanged, Threaded and Welding End.
 - .6 Includes Supplement (2010).
- .2 American Petroleum Institute (API)
 - .1 API STD 598-2009, Valve Inspection and Testing.
- .3 ASTM International (ASTM).
 - .1 .ASTM A49-12, Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.
 - .2 ASTM A182/A182M-11a, Standard Specification for Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valve Parts for High Temperature Service.
 - .3 ASTM A193/A193M-12, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications.
 - .4 ASTM A194/A194M-2011, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.
 - .5 ASTM A216/A216M-08, Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
 - .6 ASTM B85/B85M-08, Standard Specification for Aluminum-Alloy Die Castings.
- .4 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
 - .1 IPMVP 2007 Version.
- .5 Green Seal Environmental Standards (GS)
 - .1 GS-11-11, Standard for Paints and Coatings.
 - .2 GS-36-11, Standard for Commercial Adhesives.
- .6 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-25-2008, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-61-2009, Pressure Testing of Valves.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for each valve and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for incorporation into manual specified in Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for valves for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect valves from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Extra Materials/Spare Parts:
- .3 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size, minimum 1.
 - .3 Stem packing: one for every 10 valves, each size, minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.

Part 2 Products

2.1 MATERIAL

- .1 Valves:
 - .1 To be of single manufacturer.

- .2 Test valves individually.
- .2 Requirements common to valves, unless specified otherwise:
 - .1 Pressure-temperature ratings: to ANSI B16.34.
 - .2 Inspections and tests: to API 598.
 - .3 Pressure testing: to MSS SP-61.
 - .4 Flanged valves:
 - .1 Face-to-face dimensions: to ANSI B16.10.
 - .2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.
 - .5 Butt-weld valves:
 - .1 End-to-end dimensions: to ANSI B16.10.
 - .2 End dimensions: to ANSI B16.25 bored for standard pipe schedule.
 - .6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.
 - .7 Markings: to MSS SP-25.
 - .8 Identification:
 - .1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.
 - .2 Body markings: manufacturer, size, primary service rating, material symbol.
 - .9 CRN registration number required for all products.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 12, rising stem, OS Y, solid wedge disc, flanged ends, Class 150:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB, with full length disc guides designed to ensure correct re-assembly.
 - .2 Body/bonnet joint: flat face with corrugated metallic gasket.
 - .3 Bonnet studs: to ASTM A193/A193M Type B7.
 - .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
 - .5 Stuffing box: including non-galling two-piece ball jointed packing gland, with swing-type eye bolts and nuts.
 - .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
 - .7 Yoke sleeve: Ni-Resist, minimum melting point above 954 degrees C.
 - .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
 - .9 Disc: with disc stem ring to connect to stem, guided throughout its travel.
 - .1 NPS 2 1/2 - 6: solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
 - .2 NPS 8 and larger: carbon steel faced with corrosion and heat resistant 13 chromium steel with minimum hardness of 350 HB.
 - .10 Seat ring: seamless carbon steel with hard-faced cobalt-chromium-tungsten alloy seating surface, slipped in, seal welded, ground to match disc.

- .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut, T-head disc-stem connection.
- .12 Operator: see elsewhere in this Section.

2.3 VALVE OPERATORS

- .1 Install valve operators as follows:
 - .1 Handwheel: on valves except as specified.
 - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.

2.4 CHECK VALVES

- .1 NPS 2 1/2 and over, butt-weld ends, Class 150: swing check.
 - .1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.
 - .2 Cap studs: to ASTM A193/A193M Type B7.
 - .3 Cap nuts: to ASTM A194/A194M Type 2H.
 - .4 Body/cap joint: male-female face with corrugated metallic gasket.
 - .5 Disc: heat treated corrosion and heat resistant 13% chromium steel.
 - .6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.
 - .7 Hinge: ASTM A182/A182M.
 - .8 Hinge pin: ASTM A182/A182M.
 - .9 Hinge pin plugs: ASTM A182/A182M.

2.5 SILENT CHECK VALVES

- .1 Construction:
 - .1 Body: cast steel with integral seat.
 - .2 Pressure ratings: Class 125,250
 - .3 Connections: wafer ends
 - .4 Double bronze disc with SS seat and stem. Renewable disc, seat, stem and spring. Spring rating must match system design for silent operation and installation.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: regringable

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements

- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

3.3 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by cast steel valve installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 15 - Common Installation Requirements for HVAC Pipework

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1-1983 (R2006), Pipe Threads, General Purpose (Inch).
 - .2 ASME B16.1-05, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
 - .3 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings: NPS ½ through 24.
 - .4 ANSI/ASME B16.11-05, Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25-07, Buttwelding Ends.
 - .6 ANSI/ASME B16.34-04, Valves - Flanged, Threaded and Welding Ends.
- .2 American Petroleum Institute (API)
 - .1 API Std. 609-04, Butterfly Valves: Double Flanged, Lug- and Wafer-Type.
- .3 ASTM International (ASTM).
 - .1 ASTM A126-04), Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM A536-84 (2004)e1, Standard Specification for Ductile Iron Castings.
 - .3 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate Metric.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-67-02a, Butterfly Valves.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit data for valves specified in this section.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for incorporation into manual specified in Section 01 00 10 - General Requirements

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return of packaging materials in accordance with Section 01 00 10 - General Requirements

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size, minimum 1.
 - .3 Stem packing: one for every 10 valves, each size, minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
- .3 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.

Part 2 Products

2.1 BUTTERFLY VALVES - RESILIENT SEAT - 200 PSIG

- .1 Provide for all hydronic isolation valves 63mm dia. and larger unless otherwise noted.
- .2 Except to specialty valves, to be of single manufacturer.
- .3 To be suitable for dead-end service.
- .4 CRN registration number required for products.
- .5 Sizes:
 - .1 Lug type: NPS 2 to 30.
 - .2 Grooved end type: NPS 2 to 12.
- .6 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
 - .1 NPS 2 -12: 1378 kPa
- .7 Minimum seat temperature ratings to 135 degrees C.
- .8 Application:
 - .1 Isolation: On-off operation
 - .2 Isolation and flow control: throttling service where indicated
- .9 Full lug body (threaded) or Grooved ends to suit piping system.
- .10 Operators:
 - .1 NPS 2 - 6: handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge

pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.

- .11 Designed to comply with MSS SP-67 and API 609.
- .12 Compatible with ANSI Class 125/Class 150 flanges.
- .13 Construction:
 - .1 Body ductile iron.
 - .2 Disc: aluminum bronze.
 - .3 Seat: EPT.
 - .4 Shaft: 316 stainless steel.
 - .5 Taper pin: 316 SS.
 - .6 Key: stainless.
 - .7 O-Ring: EPDM.
 - .8 Bushings: Teflon.
- .14 Acceptable Material: Centerline Series 200, Apollo, Toyo

2.2 MOUNTING FLANGES

- .1 Class 125 cast iron to ANSI B16.1 or Class 150 steel to B16.5 pipe flanges.

Part 3 Execution

3.1 PREPARATION

- .1 Valve and mating flange preparation.
 - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
 - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
 - .3 Install butterfly valves with disc in almost closed position.
 - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

- .8 Install valves with unions or flanges as indicated at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.
- .9 Maintain proper clearance to permit service and maintenance.
- .10 Should deviations beyond allowable clearances arise, request and follow Engineer's directive.
- .11 Install specified valves at all branch take-offs and as indicated.

3.3 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for reuse in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 03 30 00 - Cast-in-Place Concrete.
- .3 Section 05 12 23 - Structural Steel for Buildings.
- .4 Section 05 50 00 - Metal Fabrications.
- .5 Section 23 05 48 - Vibration and Seismic Controls for HVAC.

1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-07, Power Piping.
- .2 ASTM International (ASTM)
 - .1 ASTM A125-1996 (2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 National Research Council Canada (NRC)
 - .1 National Plumbing Code of Canada 2020 (NPC).
- .6 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings for:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 00 10 - General Requirements

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse or recycling of pallets, padding, crates, and packaging materials in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
 - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
 - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
 - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
 - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.
- .2 Performance Requirements:
 - .1 Design supports, platforms, catwalks, hangers to withstand seismic events as specified Section 23 05 48 - Vibration and Seismic Controls for HVAC.

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58 and ANSI B31.1.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use electro-plating galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.

- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP69.
- .5 Upper attachment Wood Joist/Beams or Wood Deck:
 - .1 All piping 65 dia & under and all plastic DWV piping: black malleable iron, galvanized, ceiling flange, rod or pipe threaded.
- .6 Upper attachment Wall Hangers
 - .1 Carbon steel, plain, medium duty suitable for loads to 675kg, suitable for loading from top or bottom, width as required. Complying with MSS-SP-69 (Type 32).
 - .2 Bottom loads: provide carbon steel washer plate, size to suit rod size.
- .7 Shop and field-fabricated assemblies:
 - .1 Steel brackets: minimum 38mm x 38mm angle steel, 3.2mm thick.
 - .2 Unistrut channels and brackets
- .8 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm or 28 mm rod.
- .9 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .10 Adjustable clevis: material to MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .11 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.

- .12 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated.
- .13 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.6 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

2.7 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

- .1 Provide templates to ensure accurate location of anchor bolts.

2.8 HOUSE-KEEPING PADS

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.
- .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.9 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.
- .2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .3 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

3.3 HANGER SPACING

- .1 Plumbing piping: to National Plumbing Code of Canada (NPC).
- .2 Copper piping: up to NPS 1: every 1.5 m.
- .3 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.

Maximum Pipe Size NPS	Maximum Spacing Steel (m)	Maximum Spacing Copper (m)	
up to 1-1/4	2.4	1.8	
1-1/2	3.0	2.4	
2	3.0	2.4	
2-1/2	3.7	3.0	
3	3.7	3.0	
3-1/2	3.7	3.3	
4	3.7	3.6	
5	4.3		
6	4.3		
8	4.3		

- .4 Within 300 mm of each elbow.

3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.

- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.
- .2 Adjustable clevis:
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.
 - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

3.7 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 07 84 00 - Fire Stopping.
- .3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCE STANDARDS

- .1 National Research Council Canada (NRC)
 - .1 National Building Code of Canada 2020 (NBC).
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 ANSI/SMACNA 001-2008, The Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd edition
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
 - .1 D-90316, Practical Guide to Seismic Restraint, Second Edition, 2012
- .4 International Code Council (ICC) Inc.
 - .1 IMC-2018, International Mechanical Code

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 00 10 - General Requirements
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 00 10 - General Requirements. Include product characteristics, performance criteria, and limitations.
- .2 Submit shop drawings in accordance with Section 01 00 10 - General Requirements
 - .1 Seismic restraint shop drawings: Submit drawings stamped and signed by professional engineer registered or licensed in Yukon Territory, Canada.
 - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .3 Seismic Restraint System shop drawings to include:
 - .1 Full details of design criteria.
 - .2 Working drawings (prepared to same standard of quality and size as Contract Documents), materials lists, schematics, full specifications for components of each SRS to be provided.
 - .3 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables). Simplified, conservative assumptions may be acceptable.
 - .4 Separate shop drawings for each SRS and devices for each system, equipment.
 - .5 Identification of location of devices.
 - .6 Schedules of types of SRS equipment and devices.

- .7 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
- .8 Installation procedures and instructions.
- .9 Detailed design of SRS including complete working drawings (prepared to same standard of quality and size as Contract Documents), material lists, design calculations, schematics, specifications.
- .3 Quality assurance submittals: submit following in accordance with Section 01 00 10 - General Requirements
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements

1.5 DEFINITIONS

- .1 SRS: acronym for Seismic Restraint System.
- .2 Post disaster building: A building that is essential to the provision of services in the event of a disaster. This includes buildings such as hospitals, power generation facilities, communication facilities, firestations, and police stations.
 - .1 The building of this project is NOT a Post Disaster Building.

1.6 SYSTEM DESCRIPTION

- .1 Section Includes:
 - .1 Vibration isolation materials and components.
 - .2 Seismic restraint systems for statically supported and vibration isolated equipment and systems; including heating and ventilation equipment, fire protection equipment and systems, both vibration isolated and statically supported.
- .2 Seismic Restraint System
 - .1 The provision of SRS for all mechanical distribution systems and equipment includes but is not necessarily limited to the following:
 - .1 Fire protection sprinkler systems including but not limited to:
 - .1 FP piping
 - .2 FP sprinkler tree(s)
 - .3 FP fire pumps

- .2 Heating water systems including but not limited to
 - .1 HW piping
 - .2 HW pumps, fixed and vibration isolated
 - .3 HW boilers
 - .4 HW expansion, fill, and blowdown/relief tanks
- .3 Chilled water systems including but not limited to
 - .1 CW piping
 - .2 CW pumps, fixed and vibration isolated
 - .3 Chillers
 - .4 CW expansion, fill, and blowdown/relief tanks
- .4 Domestic water and sanitary systems including but not limited to
 - .1 DW and sanitary piping
 - .2 DW and sanitary pumps, fixed and vibration isolated
 - .3 Domestic Hot Water Heaters
 - .4 DW expansion tanks
- .5 All ventilation ducts.
 - .1 All ventilation ducts.
 - .2 Diffusers and grilles
 - .3 All fans, fixed and vibration isolated
 - .4 All HRV and ERV, fixed and vibration isolated
 - .5 All AHU, fixed and vibration isolated
- .2 Installation of SRS to be fully compatible with and to not affect performance of:
 - .1 Noise and vibration controls specified in this section and elsewhere in this project specification.
 - .2 Structural, mechanical, and electrical design of project.
- .3 The intent of the SRS systems is both life safety and building operation. It is the intent of the systems to maintain all equipment in operational state after a significant seismic event. During a seismic event, the SRS is to prevent systems and equipment from causing personal injury and from moving from normal position. SRS fully integrated into, and compatible with:
 - .1 Noise and vibration controls specified elsewhere.
 - .2 Structural, mechanical, electrical design of project
- .4 The SRS is to be designed by Professional Engineer specializing in design of SRS and registered in the same territory as the project..

Part 2 Products

2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 ELASTOMERIC PADS

- .1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.
- .2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.
- .3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.
- .4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

- .1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60 ; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Cadmium plate for 100% relative humidity installations.
- .4 Colour code springs.

2.5 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.
- .6 Performance: as indicated.

2.6 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.
- .6 Performance: as indicated.

2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

- .1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

2.8 FLEXIBLE CONNECTIONS

- .1 Approvals:
 - .1 CW and HW: CSA approved for pressure and temperature.
- .2 Inner Hose: Type 321 stainless steel.
- .3 Jacket: braided wire mesh Type 301 stainless steel outer jacket.
- .4 Diameter and type of end connection : as indicated.
- .5 Operating conditions:
 - .1 Working pressure: 1034 kPa
 - .2 Working temperature: 93°C.
 - .3 To match system requirements.
 - .4 Minimum lengths, flexible portion (not including end connections): 300mm
 - .5 Acceptable material: Hydroflex, Hose Master

2.9 SEISMIC CONTROL MEASURES

- .1 General
 - .1 The following systems and/or equipment to remain operational during and after earthquakes:
 - .1 Not applicable for this project
 - .2 SRS to provide gentle and steady cushioning action and avoid high impact loads.
 - .3 SRS to restrain seismic forces in every direction.
 - .4 SRS to never reach metal-like stiffness.
 - .5 Fasteners and attachment points to resist same load as seismic restraints.
 - .6 SRS of Piping systems compatible with:
 - .1 Expansion, anchoring and guiding requirements.
 - .2 Equipment vibration isolation and equipment SRS.
 - .7 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
 - .8 Attachments to RC structure:
 - .1 Use high strength mechanical expansion anchors.
 - .2 Drilled or power driven anchors not permitted.
 - .9 Seismic control measures not to interfere with integrity of firestopping.
- .2 SRS Manufacturer

-
- .1 SRS from one manufacturer regularly engaged in SRS production
 - .3 SRS for static equipment, systems
 - .1 Floor-mounted equipment, systems:
 - .1 Anchor equipment to equipment supports.
 - .2 Anchor equipment supports to structure.
 - .3 Use size of bolts scheduled in approved shop drawings.
 - .2 Suspended equipment, systems
 - .1 Use one or combination of following methods:
 - .1 Install tight to structure.
 - .2 Cross-brace in every direction.
 - .3 Brace back to structure.
 - .4 Slack cable restraint system.
 - .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
 - .3 Hanger rods to withstand compressive loading and buckling.
 - .4 SRS for vibration isolated equipment
 - .1 Floor mounted equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Vibration isolators with built-in snubbers.
 - .2 Vibration isolators and separate snubbers.
 - .3 Built-up snubber system approved by SRS designer consisting of structural elements and elastomeric layer.
 - .2 SRS to resist complete isolator unloading.
 - .3 SRS not to jeopardize noise and vibration isolation systems. Provide 6-9 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
 - .4 Cushioning action: gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
 - .2 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Slack cable restraint system.
 - .2 Brace back to structure via vibration isolators and snubbers.
 - .5 SRS for piping systems
 - .1 Fire protection systems: to NFPA 13.
 - .2 Piping systems: hangers longer than 300 mm; brace at each hanger.
 - .3 Compatible with requirements for anchoring and guiding of piping systems.
 - .6 Bracing methods:
 - .1 Structural angles or channels
 - .2 Slack Cable Restraint System (SCS)
-

- .1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.
- .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
- .3 Hanger rods to withstand compressive loading and buckling.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .3 Where isolation is bolted to floor use vibration isolation rubber washers.
- .4 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 SRS INSTALLATION

- .1 Seismic control measures to meet requirements of NBC.
- .2 Attachment points and fasteners:
 - .1 To withstand same maximum load that seismic restraint is to resist and in every direction.
- .3 Slack Cable Systems (SCS):
 - .1 Connect to suspended equipment so that axial projection of wire passes through center of gravity of equipment.
 - .2 Use appropriate grommets, shackles, other hardware to ensure alignment of restraints and to avoid bending of cables at connection points.
 - .3 Piping systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.
 - .4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
 - .5 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.
 - .6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
 - .7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.
- .4 Install SRS at least 25 mm from equipment, systems, services.

- .5 Miscellaneous equipment not vibration-isolated:
 - .1 Bolt through house-keeping pad to structure
- .6 Co-ordinate connections with other disciplines.
- .7 Vertical tanks:
 - .1 Anchor through house-keeping pad to structure.
 - .2 Provide steel bands above center of gravity.
- .8 Horizontal tanks:
 - .1 Provide at least two straps with anchor bolts fastened to structure.

3.4 FIELD QUALITY CONTROL

- .1 Seismic Restraint System Field Services:
 - .1 SRS to be inspected and certified by Seismic Engineer upon completion of installation.
 - .2 SRS Engineer to submit stamped written report(s) to Consultant verifying compliance with Contract Documents.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 00 10 - General Requirements
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.6 VIBRATION ISOLATION SCHEDULE

- .1 Roof mounted AHU: Type EP4 isolation between unit base rail and roof curb.
- .2 Roof mounted Chiller: Type EP4 isolation between unit base rail and roof curb.
- .3 Base mounted ERV: Type EP4 isolation between unit base rail and housekeeping pad.
- .4 Suspended fans, fan coil units: Type H3
- .5 Suspended fans, fan coil units: Type H3
- .6 Vertical Inline pumps: Type EP4 isolation between piping stands and housekeeping pad. See drawing details.
 - .1 For piping isolation see Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .7 End suction pumps: Type EP4 isolation between pump base and housekeeping pad. See drawing details.
 - .1 For piping isolation see Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .8 Vibration isolated equipment piping connections: flexible connections between rigid piping and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 09 91 00 - Painting

1.2 REFERENCE STANDARDS

- .1 The American Society of Mechanical Engineers (ASME International)
 - .1 ASME A13.1-2015, Scheme for the Identification of Piping Systems
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-12, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 10-2018, Standard for Portable Fire Extinguishers.
 - .2 NFPA 13-2022, Standard for the Installation of Sprinkler Systems.
 - .3 NFPA 20-2019, Standard for the Installation of Stationary Pumps for Fire Protection.
 - .4 NFPA 170-2018, Standard for Fire Safety and Emergency Symbols.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheets for labels, lamacoids, and paint and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Submittals: in accordance with Section 01 00 10 - General Requirements

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .2 Dispose of unused paint material at official hazardous material collections site approved by Authority Having Jurisdiction.
 - .3 Do not dispose of unused paint material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:
 - .2

Size#	Sizes (mm)	# of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	1	3
4	20 x 100	1	8
5	20 x 100	1	5
6	20 x 100	1	8
7	25 x 125	1	12
8	25 x 125	1	8
9	35 x 200	1	20

- .3 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: use size # 5.
 - .2 Equipment in Mechanical Rooms: use size # 9.

2.3 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Fire Protection systems and equipment: To NFPA 170.
 - .2 Fire extinguisher: To NFPA 10.
 - .3 Sprinklers: to NFPA 13.
 - .4 Fire Pump: To NFPA 20.

2.4 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
 - .1 Colours for legends, arrows: to following table:

.1

Background Colour	Legend, arrows
Orange	Black
Yellow	Black
Green	White
Red	White

- .2 Background colour marking and legends for piping systems:

.1

Contents	Background Colour	Legend
Heating Water Supply	Yellow	HWS
Heating Water Return	Yellow	HWS
Heating Glycol Water Supply	Yellow	GLS
Heating Glycol Water Return	Yellow	GLR
Chilled Water (Glycol) Supply	Yellow	CHWS
Chilled Water (Glycol) Return	Yellow	CHWR
Domestic Cold Water	Green	DCW
Domestic Hot Water	Green	DHW
Domestic Hot Water Recirculation	Green	DHWR
Reverse Osmosis Water	Green	RO
Non-Potable Cold Water	Yellow	NPCW
Acid waste	Yellow	ACID
Sanitary	Green	SAN
Sanitary Vent	Green	VENT
Storm Water	Green	STW
Radon	Yellow	RADON
Fire Protection Water	Red	FIRE PROT. WTR
Sprinklers	Red	FIRE SPRINKLER
Fire Department Connection	Red	FDC
Fire Pump Test Header	Red	FIRE PUMP TEST

2.5 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.6 VALVES, CONTROLLERS

- .1 Lamacoid tags with 12mm text or brass tags with 12 mm stamped identification data filled with black paint
- .2 Tags to include system abbreviation and valve number in the format of:
System
Valve #
- .3 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

- .1 Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TIMING

- .1 Provide identification only after painting specified Section 09 91 00 - Painting has been completed.

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and CSA registration plates as required by respective agency.

3.4 NAMEPLATES

- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
 - .1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 5 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 00 10 - General Requirements
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 01 91 13.13 - Commissioning Plan
- .3 Section 01 91 13.16 - Commissioning Forms
- .4 Section 01 91 14 - Facility Commissioning Mechanical
- .5 Section 01 91 15 - Facility Commissioning Electrical
- .6 Section 23 05 00 - Common Work Results for HVAC
- .7 Section 23 01 31 - Air Duct Cleaning for HVAC Systems
- .8 Section 23 05 03 - Mechanical Startup
- .9 Section 23 08 13 - Performance Verification of HVAC Systems
- .10 Section 23 05 23.01 - Valves - Bronze
- .11 Section 23 33 00 - Air Duct Accessories
- .12 Section 23 33 14 - Dampers - Balancing

1.2 SUMMARY

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.
- .3 Do TAB over entire operating range in accordance with most stringent conditions of this specification and standards of the following organization.
 - .1 AABC Associated Air Balance Council
 - .2 ASHRAE
- .4 For design criteria and design intent request from the Engineer copy of Design Development issue Mechanical Report to be read in conjunction with this specification and design drawings.

1.3 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Consultant within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.5 EXCEPTIONS

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.6 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.
- .3 Coordinate all work specified in this section.
- .4 Provide all facilities required by TAB Agency in order to carry out work of this section.
- .5 Coordinate with Commissioning Authority as required.
 - .1 Commissioning scope includes the witnessing of TAB activities including verification.
 - .2 Adequate notice of TAB activities for Commissioning Authority is required. A minimum of 10 business days notice prior to onsite TAB activities is required.

1.7 PRE-TAB REVIEW

- .1 Review Contract Documents before project construction is started confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Consultant in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.8 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 21, 22, 23, and 25.

1.9 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length of time required for TAB and as required by Consultant for verification of TAB reports.

1.10 START OF TAB

- .1 Notify Consultant days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weather stripping, sealing, and caulking.
 - .3 Pressure, leakage, other tests specified elsewhere Division 21, 22, and 23.
 - .4 Provisions for TAB installed and operational.
- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.

- .4 Isolating and balancing valves installed, open.
- .5 Calibrated balancing valves installed, at factory settings.
- .6 Chemical treatment systems complete, operational.

1.11 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 Ventilation Systems: plus or minus 5%.
 - .2 Hydronic systems: plus or minus 10 %.

1.12 ACCURACY TOLERANCES

- .1 Measured values accurate to within plus or minus 2 % of actual values.

1.13 INSTRUMENTS

- .1 Prior to TAB, submit to Consultant list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Consultant.

1.14 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit, prior to commencement of TAB:
 - .1 Proposed methodology and procedures for performing TAB if different from referenced standard.
 - .2 Report template including typical sheets for the various equipment present and any test plan and checklists intended to be used.
- .2 TAB submittals to be provided to Consultant and Commissioning Authority for review.

1.15 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 Summaries.

1.16 TAB REPORT

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 1 digital pdf copy of TAB Report to Consultant for verification and approval, complete with section dividers and bookmarks.

1.17 VERIFICATION

- .1 Reported results subject to verification by Consultant.
- .2 Provide personnel and instrumentation to verify up to 30 % of reported results.
- .3 Number and location of verified results as directed by Consultant.
- .4 Pay costs to repeat TAB as required to satisfaction of Consultant.

1.18 SETTINGS

- .1 After TAB is completed to satisfaction of Consultant, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.19 COMPLETION OF TAB

- .1 TAB considered complete when final TAB Report received and approved by Consultant.

1.20 AIR SYSTEMS

- .1 Standard: TAB to most stringent of this section.
- .2 Do TAB of systems, equipment, components, controls specified Division 21, 22, 23, and 25.
- .3 Qualifications: personnel performing TAB qualified to standards of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .5 Measurements to include as appropriate for systems, equipment, components, controls:
 - .1 Air velocity, Static Pressure, Velocity Pressure.
 - .2 Dry Bulb Temperature, Web Bulb Temperature.
 - .3 Cross sectional area.
 - .4 RPM, Electrical power, voltage, current draw.
 - .5 Size.
 - .6 Noise, Vibration.
- .6 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled devices, control dampers.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.21 HYDRONIC & CHILLED WATER SYSTEMS

- .1 Definitions: for purpose of this section, to include domestic water (cold, hot, recirculation, reverse osmosis), hot water heating, chilled water, condensate & glycol systems.
- .2 Measurements as required by referenced standards, including, but not limited to, following:
 - .1 Flow, pressure, temperature.

- .2 Specific gravity
- .3 RPM
- .4 Electrical Power, Voltage, Current Draw, Motor
- .3 Location of equipment measurements:
 - .1 Inlet and Outlet of each:
 - .1 Heating and chilled water and glycol system pumps.
 - .2 Domestic water pumps.
 - .4 Location of system measurements:
 - .1 HW, CW terminal units
 - .2 System circuit balancing stations
 - .3 Reheat coil circuit balancing stations
 - .5 Flow measurement methodology:
 - .1 Measure flow using flow valve manufacturer approved test instrumentation or approved alternate.

1.22 FIRE DAMPER TESTS

- .1 Provide for drop test of fire dampers by removal of fusible link.
- .2 Damper to drop and seal cleanly. Where damper fails test, advise Consultant.
- .3 Affix seal indicated test completion, date, and testing personnel to access door of FD. Where more than one access door provided, affix seal to each access door.
- .4 Provide written verification of successful completion of all fire damper drop tests and submit in draft TAB report.

Part 2 Products - Not Used

Part 3 Execution - Not Used

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 ASTM International (ASTM)
 - .1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .9 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-00, Commercial Adhesives.
- .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .7 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
- .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- .3 Packaging Waste Management: remove for reuse or recycling of pallets, crates, packaging materials, padding in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 To CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.

- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: rigid mineral fibre board unfaced or faced with factory applied vapour retarder jacket
 - .1 Mineral fibre: ASTM C612.
 - .2 Vapour Retarder Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: ASTM C612.
- .4 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket
 - .1 Mineral fibre: to ASTM C553.
 - .2 Vapour Retarder Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

- .1 Canvas:
 - .1 220 gm/m²cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Aluminum:
 - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Smooth.
 - .4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.
 - .1 Stainless steel:
 - .5 Type: 304.
 - .6 Thickness: 0.50 mm sheet.
 - .7 Finish: Smooth.
 - .8 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
 - .1 Maximum VOC limit 200 g/L to SCAQMD Rule 1168.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .5 Tape: self-adhesive, aluminum, plain, 75 mm wide minimum.
- .6 Contact adhesive: quick-setting

- .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168.
- .7 Canvas adhesive: washable.
 - .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168.
- .8 Tie wire: 1.5 mm stainless steel.
- .9 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .10 Facing: 25 mm stainless steel hexagonal wire mesh stitched on one face of insulation with expanded metal lath on other face.
- .11 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

- .1 Insulation types and thicknesses are to conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Supply ducts (unless noted otherwise)	None	--	--
Fancoil (FCU) supply ducts where concealed (above T-bar or drywall ceiling, within walls)	Rectangular: C-1 Round: C-2	Yes	25
Return ducts (unless noted otherwise)	None	--	--
Outside air ducts to mixing plenum or equipment (ERV or fan)	Rectangular: C-1 Round: C-2	Yes	50
Mixing plenum	Rectangular: C-1 Round: C-2	Yes	50
Exhaust ducts (unless noted otherwise)	None	--	--
Exhaust duct between dampers and louvers	Rectangular: C-1 Round: C-2	No	25
Exhaust duct between ERV and louvers	Rectangular: C-1 Round: C-2	No	50
Acoustically lined ducts	None	--	--

3.5 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 29 - Hanger and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE 90.1-04-SI Edition, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 ASTM International Inc.
 - .1 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .2 ASTM C449/C449M-07, Standard Specification for Mineral Fiber- Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .3 ASTM C533-07, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - .4 ASTM C547-07, Standard Specification for Mineral Fiber Pipe Insulation.
 - .5 ASTM C553-02, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .6 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-07, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit Product Data in accordance with Section 01 00 10 - General Requirements

- .2 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
- .3 Provide product data as follows:
 - .1 Insulation
 - .2 Removable Insulation Enclosures.
 - .3 Insulation Jackets
 - .4 Adhesives
- .4 Provide product data or other documentation for adhesives and sealants used in that clearly shows VOC content (in g/L).

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for reuse and return of crates in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 Fire and smoke ratings to CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre: includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: ASTM C547.
 - .2 Maximum "k" factor: ASTM C547.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52MA.

- .3 Maximum "k" factor: ASTM C547.
- .5 TIAC Code C-1: rigid mineral fibre board, unfaced.
 - .1 Mineral fibre: ASTM C612.
 - .2 Maximum "k" factor: ASTM C612.
- .6 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket.
 - .1 Mineral fibre: ASTM C612.
 - .2 Jacket: to CGSB 51-GP-52MA.
 - .3 Maximum "k" factor: ASTM C612.
- .7 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52MA.
 - .3 Maximum "k" factor: ASTM C553.
- .8 TIAC Code A.6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52MA.
 - .3 Maximum "k" factor.
 - .4 Certified by manufacturer free of potential stress corrosion cracking corrodents.
- .9 TIAC Code A-1: alumina silica continuous matt.
 - .1 Acceptable Material: Thermal Ceramics Kaowool.

2.3 CEMENT

- .1 Thermal insulating and finish to CAN/CGSB-51.12-95, service temperature to 450 deg.C low VOC to the current content limits of SCAQMD Rule #1168.

2.4 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB 51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.56 mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .8 Special requirements:

- .1 Outdoor: UV rated material at least 0.5 mm thick.
- .9 Covering adhesive: compatible with insulation.
 - .1 Maximum VOC limit 30 g/L GSES GS-36
- .2 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.
 - .1 Maximum VOC limit 30 g/L to SCAQMD Rule 1168
- .3 Aluminum:
 - .1 To ASTM B209, Apply in accordance with CSA HA Series M1980
 - .2 Thickness: 0.60 mm sheet.
 - .3 Finish: stucco embossed.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

2.5 INSULATION SECUREMENTS

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.
- .6 Facing: 25 mm galvanized steel hexagonal wire mesh on on one face of insulation with expanded metal lath on other face.
- .7 Fasteners: 4 mm diameter pins with 35 mm square clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.

2.7 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 OUTDOOR VAPOUR RETARDER MASTIC

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².

2.9 REMOVABLE PREFABRICATED INSULATED ENCLOSURES

- .1 Design: to permit periodic removal and replacement without damage to adjacent insulation, to enclose entire equipment body with minimum 50mm overlap at mating flanges or overlaps.
- .2 Insulation:
 - .1 Hot systems: BGF needled E Glass Mat, binder free. Minimum thickness or U value as indicated. Thermal Conductivity "k" shall not exceed 0.031 W/m. deg.C at 24 deg.C mean temperature when tested in accordance with ASTM C 335-95.
 - .2 Cold systems: flexible unicellular, preformed tubular elastomer to CAN/ CGSB-51.40-95, thermal conductivity "k" shall not exceed 0.04 W/m. deg.C at 24 deg.C mean temperature when tested in accordance with ASTM C 335-95, service temperature: -4degC to 100degC.
 - .3 Insulation thickness: to match piping system thermal performance.
- .3 Jacket & lining: ULC listed fiberglass cloth with Teflon coating
 - .1 Liner not required for cold systems.
- .4 Fasteners: Velcro type flap along parting edges. Cinch belts and D-rings as required.
- .5 Quilts: 300SS quilting pins with SS washers.
- .6 ID Tag: printed tags encased in plastic holder.
- .7 Construction: jacket sewn with inside seams formed to fit insulation, insulation secured with quilting pins to jacket.
- .8 Operating range: 0degC to 262degC
- .9 Acceptable material: Reflex style C8 Insulation Covers.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards
 - .1 Hot equipment: To TIAC code 1503-H.
 - .2 Cold equipment: to TIAC code 1503-C.
- .2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.
- .3 Provide vapour retarder as recommended by manufacturer.
- .4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

- .5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
- .7 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .2 Removable insulation covers shall be provided for the following:
 - .1 Where available, manufacturer supplied insulation shell pieces may be used in lieu.
 - .2 Domestic cold water pumps and assemblies.
 - .3 Domestic hot water pumps.
 - .4 Hydronic heating system pump assemblies: pumps, suction diffusers, triple duty valves.
 - .5 Chilled water system pump assemblies: pumps, suction diffusers, triple duty valves.
 - .6 Hydronic heating system valves NPS 2 and larger: ball, gate, globe and butterfly.
 - .7 Chilled water system valves NPS 2 and larger: ball, gate, globe and butterfly.
 - .8 Hydronic heating system flex connections, expansion joints.
 - .9 Chilled water system flex connections, expansion joints.
 - .10 Hydronic heating system expansion tanks.
 - .11 Chilled water system expansion tanks.
 - .12 Hydronic heating system air separators.
 - .13 Chilled water system air separators.
 - .14 Hydronic heating system heat exchangers.
 - .15 Chilled water system heat exchangers.
 - .16 Balancing valves NPS 2 and above.
 - .17 Two-Way Control valves NPS 2 and larger.
 - .18 Three-Way Control valves NPS 2 and larger.

3.5 INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 Hot Equipment:
 - .1 TIAC code A-1 with wire and 13 mm cement reinforced with one layer of reinforcing mesh.
 - .2 TIAC code C-2 unfaced with wire and 13 mm cement precede by one layer of reinforcing mesh.
 - .3 Thicknesses:

- .1 Domestic Hot Water Storage Tanks: by factory
 - .2 Thermal storage tanks: by factory
 - .3 Heat exchangers: 50mm thick removable insulation enclosure
 - .4 Pumps: manufacturer supplied insulation pieces or 25mm thick removable insulation enclosure
 - .5 Hydraulic separators, air separators: manufacturer supplied insulation pieces or 25mm thick removable insulation enclosure
- .3 Cold equipment:
- .1 TIAC A-3 with wire and 13 mm cement reinforced with one layer of reinforcing mesh.
 - .2 TIAC C-2 faced with vapour retardant jacket and with bands and 13 mm cement preceded by one layer of reinforcing mesh.
 - .3 TIAC A-6 with mechanical fastenings.
 - .4 Thicknesses: Chillers (except factory insulated) 50 mm.
 - .5 Pumps: manufacturer supplied insulation pieces or 25mm thick removable insulation enclosure
 - .6 Hydraulic separators, air separators: manufacturer supplied insulation pieces or 25mm thick removable insulation enclosure
 - .7 Backflow preventers, water meters: 25mm thick removable insulation enclosure
- .4 Finishes:
- .1 Equipment in mechanical rooms: TIAC code CEF/1 with Canvas jacket.
 - .2 Equipment elsewhere: TIAC code CEF/2 with 13 mm cement jacket.

3.6 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 ASTM International (ASTM)
 - .1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-2003, Mineral Fiber Pipe Insulation.
 - .6 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (SDS).
- .5 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.
- .7 National Energy Code for Buildings, NECB-2020

1.3 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as specified.
 - .3 "INSULATION SYSTEMS" - insulation material, fasteners, jackets, and other accessories.
- .2 TIAC Codes:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit Product Data in accordance with Section 01 00 10 - General Requirements
- .2 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
- .3 Provide product data as follows:
 - .1 Insulation
 - .2 Insulation Jackets
 - .3 Insulation Inserts
 - .4 Insulated Valve Jackets
 - .5 Adhesives
- .4 Provide product data or other documentation for adhesives and sealants used in that clearly shows VOC content (in g/L).

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 00 10 - General Requirements
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102.
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .5 Type A-4:
 - .1 Insulation:
 - .1 Rigid closed cell polyurethane insulation, formed, 50 mm min thickness.
 - .2 Properties:
 - .1 Water absorption: 4% by volume.
 - .2 Density: 35-46kg/m3.
 - .3 Compressive strength: 206kPa.
 - .4 Thermal conductivity: 0.020 to 0.026 W/m-degC.
 - .5 Operating temperatures: -45 to 120degC.
 - .3 Polymer Coating:
 - .1 Two component, fully bonded polymer coating on all exterior surfaces.
 - .2 Properties:
 - .1 Density: 1170kg/m3.
 - .2 Thickness: 1.6mm outside surfaces, 0.51mm inside surfaces.
 - .3 Acceptable material: Urecon BL-75-20EP.
 - .4 Acceptable material: Urecon.

2.3 FITTING INSERT INSULATION

- .1 TIAC Code C-2: Mineral fibre blanket insulation with factory applied vapour retarder jacket to CAN/CGSB-51.9-92 and CGSB SI-GP-52M.

- .2 Materials:
 - .1 Insulation: molded, inorganic glass fiber bonded with thermosetting resin.
 - .2 Jacket: kraft paper bonded to aluminum foil and reinforced with glass fibers.
 - .3 Lap seal: 50m stapling flange.
 - .4 Density: 16kg/m³.
- .3 Temperature range: -29degC to 121degC
- .4 Thermal Conductivity "k" shall not exceed 0.04 W/m. deg.C at 24 deg.C mean temperature when tested in accordance with ASTM C 335-95
- .5 Surface Burning Characteristics:
 - .1 To STM E84-98e, Test Method for Surface Burning Characteristics of Building Materials and ANSI/NFPA 255-2000, Burning Characteristics of Building Materials and CAN/ULC-S102-M88.
 - .2 UL Classified.
- .6 Vapour Transmission:
 - .1 To ASTM E 96-00e1, Standard Test Methods for Water Vapor Transmission of Materials.
 - .2 Maximum: 0.02 perms.
- .7 Resistance to Fungi and Bacterial growth:
 - .1 ASTM listed to not promote growth of fungi or bacteria.
- .8 Acceptable material: Knauf.

2.4 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.
- .6 Facing: 25 mm galvanized steel hexagonal wire mesh on one face of insulation.
- .7 Fasteners: 4 mm diameter pins with 35 mm diameter or square clips. Length of pin to suit thickness of insulation.

2.5 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.6 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.

2.7 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².

2.8 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.9 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint, confirm with owner.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.56 mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .8 Special requirements:
 - .1 Indoor: flame spread rating 25, smoke developed 50.
 - .2 Outdoor: UV rated material at least 0.5 mm thick.
 - .9 Covering adhesive: compatible with insulation.
- .2 Canvas:
 - .1 220 gm/m²cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.
- .3 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: stucco embossed or corrugated.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.10 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

- .1 Caulking to: Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PRE-INSTALLATION REQUIREMENT

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
 - .1 Hot equipment: To TIAC code 1503-H.
 - .2 Cold equipment: to TIAC code 1503-C or 1503-CA.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 PIPE INSULATION SCHEDULE

- .1 Hydronic Heating Pipes (rigid):
 - .1 TIAC code A-1 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
 - .2 Thickness:
 - .1 $\leq 50\text{Ø}$: 25mm
 - .2 $> 50\text{Ø}$: 38mm
 - .3 Economizer piping in Academics Wing, Commons Wing, Service Tunnel, and Energy Center: 50mm
- .3 Jackets:
 - .1 Exposed (including mechanical rooms): PVC
 - .1 Use aluminum jacket where noted on drawings.
 - .2 Concealed: none
- .2 Chilled Water Pipes (rigid):
 - .1 TIAC code A-3 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
 - .2 Thickness: 25mm
 - .3 Jackets:

- .1 Exposed (including mechanical rooms): PVC
- .2 Concealed: none

3.5 VALVES

- .1 Provide removable pre-fabricated insulated enclosures for valves as described in Section 23 07 16 - Thermal Insulation for Equipment clause 2.9 and clause 3.4.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 00 10 - General Requirements
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 RELATED SECTIONS

- .1 Section 01 00 10 - General Requirements
- .2 Section 01 91 13.13 - Commissioning Plan
- .3 Section 01 91 13.16 - Commissioning Forms
- .4 Section 01 91 14 - Facility Commissioning Mechanical
- .5 Section 01 91 15 - Facility Commissioning Electrical
- .6 Section 23 05 03 - Mechanical Start-up
- .7 Section 23 25 00 - HVAC Water Treatment Systems.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-00, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.4 ACTION AND INFORMATION SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 00 10 - General Requirements. Include product characteristics, performance criteria, and limitations.
- .2 Quality assurance submittals: submit following in accordance with Section 01 00 10 - General Requirements
 - .1 Instructions: submit manufacturer's installation instructions.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 00 10 - General Requirements
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 HYDRONIC PIPING AND EQUIPMENT DEGREASANT & DETERGENT

- .1 Neutral cleaner, compatible with all metals, non-hazardous solution which is capable of removing oil, grease, and rust from metal surfaces of system and passivating cleaned metal surfaces of system. Cleaning solution shall include:
 - .1 Low foaming non-ionic surfactant for penetrating oily and greasy deposit surfaces.
 - .2 Solvent for dissolving oil and grease.
 - .3 Dispersant for dissolving rust.
 - .4 Reducing agent for corrosion control.
 - .5 Ferrous and non-ferrous metal corrosion inhibitors.
 - .6 Minimum composition of cleaning solution:
 - .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
 - .2 Sodium carbonate: 0.40 kg per 100 L water in system.
 - .3 Low-foaming detergent: 0.01 kg per 100 L water in system.
 - .7 Acceptable material: Ferroquest FQ7103.
- .2 Liquid non-phosphorus pre-treatment program (alkaline boil-out chemical) for cooling, boiler, and heating water systems compatible with all metals. Cleaner to be capable of removing oil, grease, sludge, and rust from metal surfaces of system and passivating cleaned metal surfaces of system. Cleaning solution shall include:
 - .1 Low foaming non-ionic surfactant for penetrating oily and greasy deposit surfaces.
 - .2 Solvent for dissolving oil and grease.
 - .3 Dispersant for dissolving rust.
 - .4 Reducing agent for corrosion control.
 - .5 Ferrous and non-ferrous metal corrosion inhibitors.
 - .6 Minimum composition of cleaning solution (solid form as supplied by supplier):
 - .1 Sodium hydroxide: 5-10%
 - .2 Sodium silicate: 5-10%
 - .7 Acceptable material: Dubois Chemicals IPAC IPACLEAN PN-39

2.2 FLUSH & CLEANING WATER

- .1 All water for system flush and clean to be clean local water

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 CLEANING HYDRONIC SYSTEMS

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - .3 Use water meter to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Add chemical solution to system.

- .8 Establish circulation, raise temperature slowly to 82 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).
- .8 Glycol systems:
 - .1 In addition to procedures specified above perform specified procedures.
 - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.3 START-UP OF HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .5 Clean out strainers repeatedly until system is clean.
 - .6 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment
 - .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
 - .8 Repeat with water at design temperature.
 - .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
 - .10 Bring system up to design temperature and pressure slowly.
 - .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .12 Adjust pipe supports, hangers, springs as necessary.
 - .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .15 Check operation of drain valves.
 - .16 Adjust valve stem packings as systems settle down.
 - .17 Fully open balancing valves (except those that are factory-set).
 - .18 Check operation of over-temperature protection devices on circulating pumps.
 - .19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 00 10 - General Requirements
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 01 91 13.13 - Commissioning Plan
- .3 Section 01 91 13.16 - Commissioning Forms
- .4 Section 01 91 14 - Facility Commissioning Mechanical
- .5 Section 01 91 15 - Facility Commissioning Electrical
- .6 Section 23 01 31 - Air Duct Cleaning for HVAC Systems
- .7 Section 23 05 03 - Mechanical Start-Up
- .8 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
 - .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
 - .1 Pump operation.
 - .2 Boiler and/or chiller operation.
 - .3 Waste heat recovery heat pump operation.
 - .4 Pressure bypass open/closed.
 - .5 Control pressure failure.
 - .6 Maximum heating demand.
 - .7 Maximum cooling demand.
 - .8 Boiler and/or chiller failure.
 - .9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.5 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Heating system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
 - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
 - .2 Test procedures:
 - .1 Open fully heat exchanger, heating coil and radiation control valves.
 - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
- .7 Chilled water system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Adding heat from building heating system or;
 - .2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater that OAT. RAT to be at least 23 degrees C minimum.
 - .2 Test procedures:
 - .1 Open fully cooling coil control valves.
 - .2 Set thermostats on associated AHU's for maximum cooling.
 - .3 Set AHU's for design maximum air flow rates.
 - .4 Set load or demand limiters on chillers to 100%.

- .5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

1.6 GLYCOL SYSTEMS

- .1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

1.7 POTABLE WATER SYSTEMS

- .1 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere in Division 22 and 23.
 - .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
 - .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.8 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

- .1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 21, 22, and 23.
- .2 Verification of controls, detection devices, alarm devices is specified Division 26.
- .3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.
- .4 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.9 SANITARY AND STORM DRAINAGE SYSTEMS

- .1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.
- .2 Ensure that traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system.
- .4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.
- .5 Cleanouts: refer to Section 22 42 01 - Plumbing Specialities and Accessories.
- .6 Roof drains:
 - .1 Refer to Section 22 42 01 - Plumbing Specialities and Accessories.
 - .2 Remove caps as required.

1.10 REPORTS

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements: Reports, supplemented as specified herein.

1.11 TRAINING

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel, supplemented as specified herein.

Part 2 Products - Not Used

Part 3 Execution - Not Used

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 02 - Pipework Testing
- .3 Section 23 05 15 - Common Installation Requirements for HVAC Pipework
- .4 Section 23 05 23.01 – Valves – Bronze
- .5 Section 23 05 23.02 – Valves – Cast Iron
- .6 Section 23 05 23.03 – Valves – Cast Steel
- .7 Section 23 05 23.05 – Butterfly Valves
- .8 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .9 Section 23 05 93 - Testing, Adjusting and Balancing of HVAC.
- .10 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems
- .11 Section 23 25 00 - HVAC Water Treatment Systems

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M-11, AMD1 Specification Filler Metals for Brazing and Braze Welding.
- .2 ASME
 - .1 ANSI/ASME B16.4-06, Gray-Iron Threaded Fittings Classes 125 and 250.
 - .2 ANSI/ASME B16.15-11, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
 - .3 ANSI B16.18-12, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.22-12, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 ASTM International (ASTM)
 - .1 ASTM B32-08, Standard Specification for Solder Metal.
 - .2 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .3 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B88M-05 (2011), Standard Specification for Seamless Copper Water Tube Metric.
 - .5 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Furnish following spare parts:
 - .1 Gaskets for flanges: one for every ten flanges.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect piping from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 TUBING

- .1 Type L hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

- .1 Cast bronze threaded fittings: to ANSI/ASME B16.15.
- .2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.
- .3 Cast iron threaded fittings: to ANSI/ASME B16.4.
- .4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

2.3 FLANGES

- .1 Brass or bronze: threaded.
- .2 Cast iron: threaded.
- .3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.4 JOINTS

- .1 Solder, tin-antimony, 95:5: to ASTM B32.
- .2 Silver solder BCUP: to ANSI/AWS A5.8.
- .3 Brazing: as indicated.
- .4 Teflon Tape: for threaded joints.
- .5 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F492 complete with thermoplastic liner.

2.5 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
 - .2 NPS 2 1/2 and larger: grooved or flanged ends.
- .2 Valves to be as specified in:
 - .1 Section 23 05 23.01 – Valves – Bronze
 - .2 Section 23 05 23.02 – Valves – Cast Iron
 - .3 Section 23 05 23.03 – Valves – Cast Steel
 - .4 Section 23 05 23.05 – Valves – Butterfly

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .2 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .3 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .4 Slope piping in direction of drainage and for positive venting.
- .5 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .7 Assemble piping using fittings manufactured to ANSI standards.

3.3 VALVE INSTALLATION

- .1 Install valves in accordance with respective section for valve type:
 - .1 Section 23 05 23.01 – Valves – Bronze

- .2 Section 23 05 23.02 – Valves – Cast Iron
- .3 Section 23 05 23.03 – Valves – Cast Steel
- .4 Section 23 05 23.05 – Butterfly Valves
- .2 Install rising stem valves in upright position with stem above horizontal.
- .3 Install butterfly or ball valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .4 Install silent check valves in vertical pipes with downward flow and as indicated.
- .5 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .6 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.

3.4 TESTING

- .1 Test system in accordance with Section 23 05 02 - Pipework Testing.

3.5 CLEANING, FLUSHING, AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems and Section 23 25 00 - HVAC Water Treatment Systems.

3.6 BALANCING

- .1 In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

3.8 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by hydronic systems installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 02 - Pipework Testing
- .3 Section 23 05 15 - Common Installation Requirements for HVAC Pipework
- .4 Section 23 05 23.01 – Valves – Bronze
- .5 Section 23 05 23.02 – Valves – Cast Iron
- .6 Section 23 05 23.03 – Valves – Cast Steel
- .7 Section 23 05 23.05 – Butterfly Valves
- .8 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .9 Section 23 05 93 - Testing, Adjusting and Balancing of HVAC.
- .10 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems
- .11 Section 23 25 00 - HVAC Water Treatment Systems

1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1-10, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .2 ASME B16.3-06, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .3 ASME B16.5-09, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
 - .4 ASME B16.9-07, Factory-Made Wrought Buttwelding Fittings.
 - .5 ASME B18.2.1-10, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).
 - .6 ASME B18.2.2-10, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- .2 ASTM International (ASTM)
 - .1 ASTM A47/A47M-99 (2009), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-84 (2009), Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202-10, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Furnish following spare parts:
 - .1 Gaskets for flanges: one for every ten flanges.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect piping from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS 6: Schedule 40.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with PTFE tape.
- .2 NPS 2-1/2 and over: grooved
- .3 Roll grooved: standard coupling to CSA B242.
- .4 Flanges: plain, to ANSI/AWWA C111/A21.11.
- .5 Orifice flanges: slip-on raised face, 2100 kPa.

- .6 Flange gaskets: to ANSI/AWWA C111/A21.11.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: to ASME B18.2.2.
- .9 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Steel: to ASME B16.5.
- .3 Unions: malleable iron, to ASTM A47/A47M.
- .4 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
 - .2 NPS 2 1/2 and larger: grooved or flanged ends.
- .2 Valves to be as specified in:
 - .1 Section 23 05 23.01 – Valves – Bronze
 - .2 Section 23 05 23.02 – Valves – Cast Iron
 - .3 Section 23 05 23.03 – Valves – Cast Steel
 - .4 Section 23 05 23.05 – Valves – Butterfly

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .2 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .3 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .4 Slope piping in direction of drainage and for positive venting.
- .5 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .7 Assemble piping using fittings manufactured to ANSI standards.

3.3 VALVE INSTALLATION

- .1 Install valves in accordance with respective section for valve type:
 - .1 Section 23 05 23.01 – Valves – Bronze
 - .2 Section 23 05 23.02 – Valves – Cast Iron
 - .3 Section 23 05 23.03 – Valves – Cast Steel
 - .4 Section 23 05 23.05 – Butterfly Valves
- .2 Install rising stem valves in upright position with stem above horizontal.
- .3 Install butterfly or ball valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .4 Install silent check valves in vertical pipes with downward flow and as indicated.
- .5 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .6 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.

3.4 TESTING

- .1 Test system in accordance with Section 23 05 02 - Pipework Testing.

3.5 CLEANING, FLUSHING, AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems and Section 23 25 00 - HVAC Water Treatment Systems.

3.6 BALANCING

- .1 In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

3.8 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by hydronic systems installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 02 - Pipework Testing
- .3 Section 23 05 15 - Common Installation Requirements for HVAC Pipework
- .4 Section 23 05 23.01 – Valves – Bronze
- .5 Section 23 05 23.02 – Valves – Cast Iron
- .6 Section 23 05 23.03 – Valves – Cast Steel
- .7 Section 23 05 23.05 – Butterfly Valves
- .8 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .9 Section 23 05 93 - Testing, Adjusting and Balancing of HVAC.
- .10 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems
- .11 Section 23 25 00 - HVAC Water Treatment Systems

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM D2842- 12, Standard Test Method for Water Absorption of Rigid Cellular Plastics.
 - .2 ASTM D3574-11, Standard Method of Testing Flexible Cellular Materials - Slab, Bonded and Molded Urethane Foams.
 - .3 ASTM D6226-10, Standard Test Method for Open Cell Content of Rigid Cellular Plastics.
 - .4 ASTM E96/E96M-12, Standard Test Methods for Water Vapour Transmission of Materials.
 - .5 ASTM F876 Standard Specification for Crosslinked Polyethylene (PEX) Tubing
 - .6 ASTM F877 Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
 - .7 ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing
- .2 CSA Group
 - .1 CAN/CSA B137.5 Standard Specification for Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications
- .3 Underwriters Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Shop drawings:
 - .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for factory pre-insulated piping systems for utility applications and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.
- .3 Record Drawings: submit data necessary to produce record drawings on project completion and following requirements:
 - .1 Give details of pipe material, location of fittings, maintenance and operating instructions.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect piping from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements

1.6 APPLICABLE SYSTEMS

- .1 Piping and fittings described in this section are applicable for the following systems:
 - .1 Underground heating water piping between the new building of this project and the existing Academic Wing for the Flue Gas Economizer System link between the new building of this project and the new Flue Gas Economizer System being installed in the existing Energy Center.

Part 2 Products

2.1 PRE-INSULATED THERMAL PEX - SMOOTH JACKET

- .1 Service Tubing:
 - .1 Material: Crosslinked polyethylene (PEX) manufactured to PEX-a or Engel-method standard. Manufactured in accordance with ASTM F876 and F877
 - .2 Pressure Ratings: Hydrostatic design and pressure ratings are in accordance with the ASTM standard. Operating limits are as follows:
 - .1 -50 degrees C to 95 degrees C at 551 kPA
 - .3 PEX tubing to have an oxygen diffusion barrier that does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 104 degrees F (40 degrees C) water temperature in accordance with German DIN 4726.

- .4 Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated
- .2 Outer Jacket:
 - .1 Material is smooth seamless low-density polyethylene (LDPE).
 - .2 The outer jacket completely encompasses and protects the insulation from moisture and damage.
 - .3 The outer jacket to be extruded directly over the insulation and to be flexible.
 - .4 The outer jacket to contain 2 percent carbon black, finely divided and thoroughly dispersed to provide protection from UV degradation.
 - .5 Minimum Bend Radius as per manufacturer.
- .3 Insulation:
 - .1 The insulation shall be semi-flexible water-resistant polyurethane closed-cell foam.
 - .2 Insulation shall be bonded to the service tubing and outer jacket
 - .3 Insulation thickness: minimum 50mm
- .4 Cold Expansion Fittings for PEX-a Service Tubing:
 - .1 For system compatibility, use fittings offered by the tubing manufacturer.
 - .2 Fittings must comply with the performance requirements of ASTM F877.
 - .3 Fittings are to be manufactured in accordance with ASTM F1960.
 - .4 The fitting assembly consists of a barbed adapter and appropriately sized PEX ring.
 - .5 All buried fittings will be installed, insulated, and sealed in accordance with the instructions of the piping manufacturer.
- .5 Compression Fittings for PEX Service Tubing:
 - .1 For system compatibility, use fittings offered by the tubing manufacturer.
 - .2 Fittings are to be manufactured from dezincification-resistant brass.
 - .3 The fitting assembly must comply with performance requirements of ASTM F877.
 - .4 The fittings will consist of a compression fitting with a coupling sleeve, a fitting body insert with o-ring(s) and a bolt and nut.
 - .5 All buried fittings will be installed, insulated, and sealed in accordance with the piping manufacturer's instructions.
 - .6 All transition fittings connecting to the compression fittings shall be manufactured of dezincification-resistant brass.
- .6 Valves
 - .1 For system compatibility, use valves as recommended or as offered by the tubing manufacturer.
 - .2 Where valves are not available:
 - .1 Valves to be as specified in:
 - .1 Section 23 05 23.01 – Valves – Bronze
 - .2 Section 23 05 23.02 – Valves – Cast Iron
 - .3 Section 23 05 23.05 - Valves - Butterfly

- .2 For threaded valves: Utilize PEX to NPT thread adapter and threaded valve
- .3 For flanged valves: Utilize PEX to NPT thread adapter, NPT thread to flange adapter, and flanged valve
- .7 Joints & Fittings Insulation Kits:
 - .1 Insulation kits will be manufactured of LDPE sleeves or manufacturer supplied heat shrink material and will feature equal thickness of closed-cell PEX insulation as the pipe.
 - .2 Insulation kits will be sealed watertight.
- .8 Acceptable Material:
 - .1 Urecon Pre-Insulated Pex-Flex Pipe with custom insulation thickness as specified.

2.2 BURIED WARNING AND IDENTIFICATION TAPE

- .1 Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping.
- .2 Tape: detectable by electronic detection instrument.
- .3 Provide tape in rolls, 75 mm minimum width, colour coded for utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length.
- .4 Warning and identification: reading CAUTION BURIED PRE-INSULATED PIPING BELOW or similar wording.
- .5 Use permanent code and letter colouring unaffected by moisture and other substances contained in trench backfill material.

2.3 PIPE BEDDING AND SURROUND MATERIALS

- .1 Granular material to following requirements:
 - .1 Crushed or screened stone or sand consisting of hard, durable, particles, free from clay lumps, cementation, organic material and other deleterious materials.
 - .2 Gradations to be within limits specified when tested to ASTM C117. Sieve sizes to CAN/CGSB-8.2.
- .2 Concrete for cradles, encasement, supports, thrust blocks: in accordance with Section 03 30 00 - Cast-in-Place Concrete.

2.4 PIPE SLEEVES

- .1 Provide sleeves where piping passes entirely through walls and floors.
- .2 Ensure sleeves are of sufficient length to pass through entire thickness of walls and floors.
- .3 Provide 25 mm minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole.
- .4 Firmly pack space with mineral wool insulation.
- .5 Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to firm but pliable mass, provide mechanically adjustable segmented elastomeric seal.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.
- .2 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .3 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .4 Slope piping in direction of drainage and for positive venting.
- .5 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .7 Assemble piping using fittings manufactured to ANSI standards.

3.3 VALVE INSTALLATION

- .1 Install valves in accordance with respective section for valve type:
 - .1 Section 23 05 23.01 – Valves – Bronze
 - .2 Section 23 05 23.02 – Valves – Cast Iron
 - .3 Section 23 05 23.03 – Valves – Cast Steel
 - .4 Section 23 05 23.05 – Butterfly Valves
- .2 Install rising stem valves in upright position with stem above horizontal.

3.4 REPAIRING DAMAGED PRE-INSULATED PIPE

- .1 Repair damage to outer jacket by applying heat shrink sleeve as reviewed by Consultant or cover using heated HDPE UV resistant adhesive backed tape.

3.5 INSULATION OF FITTINGS

- .1 Cut pipes as required to accommodate fittings and fitting insulation kits without damaging pipe insulation or its jacket.
 - .1 Leave smooth end at right angles to pipe axis.
- .2 Cracks larger than 6.4 mm to be filled with insulation foamed-in-place in following manner:
 - .1 Use strip of thin galvanized sheet metal wide enough to overlap both insulation kit and pipe by at least 8 cm and long enough to wrap around pipe leaving 2.5 cm opening on top.
 - .2 Hold metal in place with two tension metal or nylon straps, one at either end.

- .3 Spray foam through opening on top into cavity.
- .4 Spray until cavity is almost half-filled on both sides of pipe.
 - .1 Foam will rise to complete filling.
- .5 Allow to cure for 10 to 15 min.
- .6 Trim top and apply waterproofing sealant asphalt mastic, HDPE tape or heat shrink tape.

3.6 TESTING

- .1 Test system in accordance with Section 23 05 02 - Pipework Testing as supplemented herein.
- .2 Test pipes for obstructions using "pig" test.
 - .1 Unobstructed pipes: when wood or metal ball, having diameter 19 mm less than inside diameter of pipe can be readily pulled through pipe line.
 - .2 Repair or replace mains which do not pass pig test.
- .3 Protect piping from freezing if testing at temperatures lower than minus 5°C.

3.7 CLEANING, FLUSHING, AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems and Section 23 25 00 - HVAC Water Treatment Systems.

3.8 BALANCING

- .1 In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.9 CLEANING

- .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.10 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by hydronic systems installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 02 - Pipework Testing
- .3 Section 23 05 15 - Common Installation Requirements for HVAC Pipework
- .4 Section 23 05 23.01 – Valves – Bronze
- .5 Section 23 05 23.02 – Valves – Cast Iron
- .6 Section 23 05 23.03 – Valves – Cast Steel
- .7 Section 23 05 23.05 – Butterfly Valves
- .8 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .9 Section 23 05 93 - Testing, Adjusting and Balancing of HVAC.
- .10 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems
- .11 Section 23 25 00 - HVAC Water Treatment Systems

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME-04(2007), Boiler and Pressure Vessel Code.
- .2 ASTM International Inc.
 - .1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278/A278M-01(2006), Standard Specification for Gray Iron
 - .3 Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .4 ASTM A516/A516M-06, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .5 ASTM A536-84(2004), Standard Specification for Ductile Iron Castings.
 - .6 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B51-03(R2003), Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CSA B51-03(R2005), Boiler, Pressure Vessel, and Pressure Piping Code, Supplement #1.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit Shop Drawings and provide manufacturer's printed product literature and datasheets for expansion tanks, air vents, separators, valves, and strainers and

include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance and operation data in accordance with Section 01 00 10 - General Requirements

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 THERMAL STORAGE TANK - VERTICAL

- .1 Vertical large volume top-coat thermal storage tank.
- .2 Warranty: minimum 5-year warranty.
- .3 Construction:
 - .1 Material: Pressure vessel carbon steel plate with dished heads
 - .2 Constructed and Certified: In accordance with ASME Boiler and Pressure Vessel Code ASME IV, Part HLW for 125 PSI (862 kPa) and so labeled, CSA B51, and territorial regulations.
 - .3 Submit certificate of CRN registration as required by territorial authorities.
 - .4 Pressure & Temperature: hydrostatically tested for 125 PSI (862 kPa) working pressure and suitable for water temperatures up to 180°F (82°C).
 - .5 Lifting lugs: integral, minimum of 2
 - .6 Manway: 12"x16" (305mmx406mm) diameter Manway opening allow removal of sediment and inspection of interior surface.
- .4 Connections:
 - .1 Inlet/outlets:
 - .1 Top: 3" NPT, located center of shell head
 - .2 Bottom: 3" NPT, located low as practical on tank shell above bottom shell head
 - .2 Drain: 1" NPT, center bottom shell head, complete with drain valve that is located near edge of tank for ease of access.
 - .3 Pressure/Thermal Relief: min 1-1/4" NPT, offset from top center inelt/outlet connection
 - .4 Temperature sensor ports: 3/4" NPT on side of tank, suitable for thermowell.
 - .1 Refer to drawing schedule and schematic for quantity and locations.
 - .5 Thermometer ports: 3/4" NPT on side of tank, suitable for thermowell.
 - .1 Refer to drawing schedule and schematic for quantity and locations.

- .6 Anodes: minimum 2, size and location per manufacturer's recommendation
 - .1 Anodes to be magnesium.
- .5 Exterior finish: red oxide primer.
- .6 Internal lining
 - .1 All internal surfaces of the tank exposed to water shall be glass-lined with Vitraglas® or Ultonium® vitreous enamel that has been fused to steel by firing at a temperature range of 1,600°F (871°C).
 - .2 Single coat finished thickness shall be 10 to 12 mils.
- .7 Insulation
 - .1 Sprayed-On Rigid Insulation:
 - .1 High density polyurethane spray foam insulation with a class I foam rating with less than a 25-flame spread rating suitable for boiler room applications.
 - .2 Insulation shall be applied at the factory at room temperature directly to the tank in a 2 step application process with a maximum of 2" (50mm) of foam added per application.
 - .3 Minimum thickness: 3" (75mm) for a minimum insulation value of R-20.
 - .2 Topcoat: full encapsulated with a 100% acrylic top coat
 - .1 Acrylic to be applied in a 2 step application process, applying approximately 12.5 mils of material per coat and allowed to dry between applications.
- .8 Sparge tube diffuser
 - .1 General:
 - .1 Intended to slow water flow into tank and minimize turbulence such that tank temperature stratification is maintained to maximize tank hot water delivery. Sparge tube diffuser to allow 80%+ of the tanks usable water to be drawn without a noticeable outlet temperature variation.
 - .2 Materials: heavy gauge stainless steel
 - .3 Construction:
 - .1 Designed with an angled plate opening along the bottom of the tube. The angled plate opening will have a 30% more combined volume than the sparge tube which will allow the incoming water to slow and gently enter the tank maintaining temperature stratification.
 - .4 Connection: 3" NPT dielectric double threaded fitting
 - .5 Acceptable materials:
 - .1 Bradford White Hydrojet HC
 - .2 Niles Steel Tank Diverter Tube
- .9 Supports: steel skirt with hold down bolts and installation templates incorporating seismic restraint systems.
- .10 Schedule: see drawings
- .11 Acceptable material: refer to drawing schedule

2.2 EXPANSION TANK - FULL ACCEPTANCE BLADDER TYPE

- .1 Vertical expansion tank with threaded pipe connections and full acceptance bladder.
- .2 Construction:
 - .1 ASME code rated welded tank to 860 kPa test pressure of ASTM A516/ A516M, pressure vessel carbon steel plate with dished heads, painted with red oxide primer after manufacture.
 - .2 Conform to: ANSI/ASME BPVC, Section VIII and CSA B51, and provincial regulations.
 - .3 Submit certificate of registration as required by provincial authorities.
 - .4 Replaceable full acceptance heavy duty butyl bladder, min 0.100 in thick.
- .3 Accessories:
 - .1 Expansion pipe connection at top, sized for tank volume
 - .2 NPS 1 drain connection at bottom with drain valve.
 - .3 Air valve: Schrader valve with EPDM seats
 - .4 Service hole - min 250mm Ø opening on top for bladder replacement.
- .4 Factory pre-charged to 84 kPa.
- .5 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems.
- .6 Schedule: see drawings
- .7 Acceptable material: refer to drawing schedule

2.3 EXPANSION TANK - PARTIAL ACCEPTANCE BLADDER TYPE

- .1 Vertical expansion tank with threaded pipe connections and partial acceptance bladder.
- .2 Construction:
 - .1 ASME code rated welded tank to 860 kPa test pressure of ASTM A516/ A516M, pressure vessel carbon steel plate with dished heads, painted with red oxide primer after manufacture.
 - .2 Conform to: ANSI/ASME BPVC, Section VIII and CSA B51, and provincial regulations.
 - .3 Submit certificate of registration as required by provincial authorities.
 - .4 Replaceable partial acceptance heavy duty butyl bladder, min 0.100 in thick.
- .3 Accessories:
 - .1 Expansion pipe connection at top, sized for tank volume
 - .2 NPS 1 drain connection at bottom with drain valve.
 - .3 Air valve: Schrader valve with EPDM seats
 - .4 Service hole - min 250mm Ø opening for bladder replacement.
- .4 Factory pre-charged to 84 kPa.
- .5 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems.
- .6 Schedule: see drawings

- .7 Acceptable material: refer to drawing schedule

2.4 EXPANSION TANK - DIAPHRAGM TYPE

- .1 Vertical pressurized diaphragm type expansion tank.
- .2 Size: as indicated.
- .3 Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.
- .4 Heavy Duty Butyl Bladder.
- .5 Working pressure: 860 kPa.
- .6 Air precharged to 84 kPa (initial fill pressure of system).
- .7 Base mount for vertical installation.
- .8 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems.
- .9 Renewable diaphragm.
- .10 Schedule: As per drawings.
- .11 Acceptable Material: Amtrol

2.5 PRESSURE RELIEF VALVES

- .1 Screwed, bronze body or cast iron body with expanded outlet.
- .2 ASME rated.
- .3 Coordinate with sizes and pressures indicated on drawings (plans and schematics).
- .4 Acceptable Products:
 - .1 Bronze body: Watts 174A, NPS 3/4 to NPS 2.
 - .2 Iron body: Watts 740, NPS 3/4 x 1 to NPS 2 x 2-1/2.

2.6 AUTOMATIC AIR VENT

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 310 kPa working pressure.
- .2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.
- .3 Float: solid material suitable for 115 degrees C working temperature.
- .4 Vent isolation valve: class 600, regular port, threaded, bronze body, plated brass ball, brass gland and PTFE Teflon seat, wing handle, screwed.

2.7 AIR SEPARATOR - IN LINE - VORTEX TYPE

- .1 Steel, tested and stamped in accordance with ANSI/ASME PRVC with galvanized steel integral strainer with 5mm perforations, tangential inlet and outlet connections and internal stainless steel air collector tube.
- .2 Ratings: minimum 1100 kPa at 177 °C
- .3 Connections: NPT independent vent and blow down, flanged inlet and discharge.
- .4 Acceptable Material: Spirovent, Amtrol, Bell & Gossett.

2.8 HYDRAULIC SEPARATOR

- .1 Combination hydraulic, air, dirt and magnetic separator.
- .2 Separator body: epoxy resin painted steel body
- .3 Internal element: 300 series stainless steel coalescing mesh
- .4 Air vent: automatic type, brass body, VITON seal, stainless steel float, brass isolation valve.
- .5 Shut-off and drain valve: 32mmØ brass
- .6 Flange connections: ANSI B16.5 Class 150 RF
- .7 Approvals:
 - .1 Designed and built in accordance with Section VIII, Div. 1 of the ASME Boiler and Pressure Vessel Code and
 - .2 CRN Registered
 - .3 Stamped for 150 psi (10 bar) working pressure, with ASME U stamp.
- .8 Performance
 - .1 Fluids: suitable for use with water and non-hazardous glycol solutions up to 50%
 - .2 Maximum working pressure: 150 psi (10 bar).
 - .3 Temperature range:
 - .1 With insulation: 0 to 105°C
 - .2 Without insulation (vessel): 0 to 132°C
 - .4 Particle separation capacity: to 5 µm (0.2 mil).
 - .5 Air separation capacity: 100% removal to micro-bubble level.
- .9 Insulation Shell:
 - .1 Material: rigid closed cell expanded polyurethane foam
 - .2 Thickness: 60 mm
 - .3 Density: 45 kg/m³
 - .4 Conductivity (ISO 2581): 0.023 W/(m·K)
 - .5 Temperature range: 0 to 105°C
 - .6 Outer cover: embossed aluminum, 0.70 mm
- .10 Connection size: refer to drawings & schematics
- .11 Flow rate: refer to drawings & schematics
- .12 Acceptable material: Caleffi SEP4 NA549-M series

2.9 AIR AND DIRT SEPARATOR

- .1 Combination air, dirt and magnetic separator.
- .2 Separator body: epoxy resin painted steel body
- .3 Internal element: 300 series stainless steel coalescing mesh
- .4 Air vent: automatic type, brass body, VITON seal, stainless steel float, brass isolation valve.
- .5 Shut-off and drain valve: 32mmØ brass

- .6 Flange connections: ANSI B16.5 Class 150 RF
- .7 Approvals:
 - .1 Designed and built in accordance with Section VIII, Div. 1 of the ASME Boiler and Pressure Vessel Code and
 - .2 CRN Registered
 - .3 Stamped for 150 psi (10 bar) working pressure, with ASME U stamp.
- .8 Performance
 - .1 Fluids: suitable for use with water and non-hazardous glycol solutions up to 50%
 - .2 Maximum working pressure: 150 psi (10 bar).
 - .3 Temperature range:
 - .1 With insulation: 0 to 105°C
 - .2 Without insulation (vessel): 0 to 132°C)
 - .4 Particle separation capacity: to 5 µm (0.2 mil).
 - .5 Air separation capacity: 100% removal to micro-bubble level.
- .9 Connection size: refer to drawings & schematics
- .10 Flow rate: refer to drawings & schematics
- .11 Acceptable material: Caleffi DISCAL DIRTMAG NA546-M series

2.10 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

- .1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.

2.11 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.
- .2 NPS 2 1/2 to 12: cast steel body to ASTM A278/A278M, Class 30, flanged connections.
- .3 NPS 2 to 12: T type with malleable iron body to ASTM A47M, grooved ends.
- .4 Blowdown connection: NPS 1.
- .5 Screen: stainless steel with 1.19 mm perforations.
- .6 Working pressure: 860 kPa.

2.12 SUCTION DIFFUSER

- .1 Body: cast iron with screwed connections.
- .2 Strainer: with built-in, disposable 1.19 mm mesh, low pressure drop screen and NPS 1 blowdown connection.
- .3 Permanent magnet particle trap.
- .4 Full length straightening vanes.
- .5 Pressure gauge tapings.
- .6 Adjustable support leg

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 GENERAL

- .1 Run drain lines and blow off connections to terminate above nearest drain.
- .2 Maintain adequate clearance to permit service and maintenance.
- .3 Should deviations beyond allowable clearances arise, request and follow Engineer's directive.
- .4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.3 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve except at radiation and as indicated.

3.4 AIR VENTS

- .1 Install at high points of systems.
- .2 Install ball valve on automatic air vent inlet. Run discharge to nearest service sink.

3.5 EXPANSION TANKS

- .1 Adjust expansion tank pressure to suit design criteria.
- .2 Install lockshield type valve at inlet to tank.

3.6 PRESSURE SAFETY RELIEF VALVES

- .1 Run discharge pipe to terminate above nearest drain.

3.7 SUCTION DIFFUSERS

- .1 Install on inlet to pumps having suction size greater than 80Ømm or where indicated.

3.8 CLEANING

- .1 Clean in accordance with Section 01 00 10 - General Requirements
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
 - .2 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 03 - Mechanical Start-Up
- .3 Section 23 08 13 - Performance Verification of HVAC Systems

1.2 REFERENCE STANDARDS

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IES Standard 90.1-2022, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group (CSA)
 - .1 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.
 - .2 CAN/CSA No. 108, Liquid Pumps.
- .3 Electrical Equipment Manufacturers Association of Canada (EEMAC)
- .4 National Electrical Manufacturers' Association (NEMA)
 - .1 NEMA MG 1-2011, Motors and Generators.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for pump, circulator, and equipment and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.
- .3 Shop Drawings:
 - .1 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.
- .3 Submit electronic copies of operation and maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect hydronic pumps from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 EQUIPMENT

- .1 Size and select components to: CAN/CSA-B214.

2.2 INLINE WET ROTOR CIRCULATORS - CONSTANT VOLUME

- .1 Construction: Aluminum oxide ceramic shaft and radial bearings. Carbon thrust bearing and EPDM retainer. Stainless steel inlet cone, rotor can, rotor cladding, bearing plate, shaft retainer. Corrosion-resistance impeller. EPDM O-ring and gaskets. Composite terminal box. Bronze or stainless-steel pump housing. Integral 3-speed motor and selection switch
- .2 Inline or base mounted as required.
- .3 Rated Pressure: 1000 kPa minimum
- .4 Operating Temperature: 110°C
- .5 Approvals: CSA, UL listed.
- .6 Voltage: as per drawing schedules.
- .7 Acceptable Material: Grundfos UPS series
- .8 Schedule: as per drawing schedules.

2.3 INLINE WET ROTOR CIRCULATORS - VARIABLE SPEED - SMALL

- .1 Construction: Cast iron or bronze pump housing, stainless steel rotor can, bearing plate and rotor cladding, ceramic shaft and radial bearings, carbon thrust bearing, composite or stainless steel impeller, EPDM O-ring and gaskets, composite control box. Integral variable speed drive and controller.
- .2 Operating Temperature Range: 2-95°C
- .3 Ambient Temperature Range: 0-55°C
- .4 Rated Pressure: 1000 kPa minimum
- .5 Approvals: CSA, UL listed.
- .6 Voltage: as per drawing schedules.
- .7 Acceptable Material: Grundfos ALPHA series
- .8 Schedule: as per drawing schedules.

2.4 INLINE WET ROTOR PUMP - VARIABLE SPEED - LARGE

- .1 General:
 - .1 Pump shall be of the in-line wet rotor design. Oil lubricated pumps and shaft coupled pumps shall not be accepted.
 - .2 The pump shall be a standard product of a single pump manufacturer. The pump, motor, and variable speed drive shall be an integral product designed and built by the same manufacturer.
 - .3 The enclosure shall be marked "Enclosure Type 2."
 - .4 The pump shall be certified and listed by a Nationally Recognized Test Laboratory (NRTL) for U.S. and Canada to comply with CAN/CSA no. 108
 - .5 The pump shall be labeled on the nameplate as having an Energy Efficiency Index (EEI) of no greater than 0.20.
- .2 Ratings:
 - .1 Maximum Pressure: 1206 kPa
 - .2 Minimum Media Temperature: -10°C
 - .3 Maximum Media Temperature: 110°C
 - .4 Maximum Continuous Media Temperature: 95°C
 - .5 Maximum Sound Pressure Level: 43dB(A)
 - .6 Voltage: 1x115V +/-10% or 1x208-230V +/-10% per drawing schedules
 - .7 Maximum Energy Efficiency Index: 0.20
- .3 Construction:
 - .1 Pump housing:
 - .1 Cast Iron EN-JGL-250 with Cataphoresis surface treatment
 - .2 Stainless Steel: 304 Stainless
 - .2 Impellers: Composite PES 30% GF
 - .3 Rotor Can: PPS reinforced with Carbon Fiber(Fortran MT9141L PPS-GF40).
 - .4 Rotor Cladding: 316 Stainless Steel
 - .5 Stator Housing: Aluminum
 - .6 Shaft: 316L Stainless Steel
 - .7 Thrust Bearing:
 - .1 Axial: Carbon Graphite
 - .2 Radial: Ceramic
 - .8 O-Rings: EPDM
 - .9 Bearing Plate: 304 Stainless Steel
 - .10 Neck Ring: 304 Stainless Steel
 - .11 Control Box: Polycarbonate
- .4 Motor:
 - .1 Motor shall be 4-pole permanent-magnet (PM motor) and tested with the pump as one unit by the same manufacturer. Conventional asynchronous squirrel-cage motors shall not be acceptable.

- .2 Each motor shall be of the integrated Variable Speed Drive design consisting of a motor and a Variable Frequency Drive (VFD) built and tested as one unit by the same manufacturer.
- .3 The stator housing shall be made of pressure die cast aluminum.
- .4 The motor shall be cooled by the pumped fluid
- .5 The power electronics shall be cooled to the ambient air.
- .6 The Motor shall be self-ventilating.
- .7 Minimum insulation class for the motor shall be Class F.
- .8 The integrated VFD control shall utilize an energy optimization algorithm to minimize energy consumption by reducing the factory-set setpoint and adjust to system characteristics. This shall be accomplished without the need of any external sensors or input.
- .5 Acceptable Material: Grundfos MAGNA1 or MAGNA3 series
- .6 Schedule: As per drawing schedules.

2.5 END SUCTION PUMP - VARIABLE SPEED

- .1 General:
 - .1 Pump shall be of the end suction centrifugal volute with axial inlet port, radial outlet port, and horizontal shaft with back pull-out design. Oil lubricated pumps and shaft coupled pumps shall not be accepted.
 - .2 The pump shall be a standard product of a single pump manufacturer. The pump, motor, and variable speed drive shall be an integral product designed and built by the same manufacturer.
 - .3 The enclosure shall be marked "Enclosure Type 2."
 - .4 The pump shall be certified and listed by a Nationally Recognized Test Laboratory (NRTL) for U.S. and Canada to comply with CAN/CSA no. 108
 - .5 The pump shall be labeled on the nameplate as having an Energy Efficiency Index (EEI) of no greater than 0.20.
- .2 Ratings:
 - .1 Maximum Pressure: 1206 kPa
 - .2 Minimum Media Temperature: -10°C
 - .3 Maximum Media Temperature: 110°C
 - .4 Maximum Continuous Media Temperature: 95°C
 - .5 Maximum Sound Pressure Level: 43dB(A)
 - .6 Voltage: per drawing schedules
 - .7 Maximum Energy Efficiency Index: 0.20
- .3 Construction:
 - .1 Motor stool: ASTM Class 30 cast Iron
 - .2 Pump housing: ASTM Class 30 cast Iron
 - .3 Impellers: Stainless steel
 - .4 Shaft: 316L Stainless Steel
 - .5 Thrust Bearing:

- .1 Axial: Carbon Graphite
- .2 Radial: Ceramic
- .6 O-Rings: EPDM
- .7 Bearing Plate: 304 Stainless Steel
- .8 Neck Ring: 304 Stainless Steel
- .9 Control Box: Polycarbonate
- .4 Motor:
 - .1 Motor shall be a permanent-magnet (PM) motor and tested with the pump as one unit by the same manufacturer. Conventional asynchronous squirrel-cage motors shall not be acceptable.
 - .2 Each motor shall be of the integrated Variable Speed Drive design consisting of a motor and a Variable Frequency Drive (VFD) built and tested as one unit by the same manufacturer.
 - .3 The motor shall be cooled by ambient air.
 - .4 The power electronics shall be cooled to the ambient air.
 - .5 The Motor shall be self-ventilating.
 - .6 Minimum insulation class for the motor shall be Class F.
 - .7 The integrated VFD control shall utilize an energy optimization algorithm to minimize energy consumption by reducing the factory-set setpoint and adjust to system characteristics. This shall be accomplished without the need of any external sensors or input.
- .5 Acceptable Material: Grundfos NBSE series
- .6 Schedule: As per drawing schedules.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.2 INSTALLATION

- .1 Install hydronic pumps to: CAN/CSA-B214.
- .2 In line circulators: install as indicated by flow arrows.
 - .1 Support at inlet and outlet flanges or unions.
 - .2 Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement.
 - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
 - .2 Align coupling in accordance with manufacturer's recommended tolerance.
 - .3 Check oil level and lubricate. After run-in, tighten glands.
- .4 Ensure that pump body does not support piping or equipment.
 - .1 Provide stanchions or hangers for this purpose.
 - .2 Refer to manufacturer's installation instructions for details.

- .5 Pipe drain tapping to floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.

3.3 START-UP

- .1 General:
 - .1 In accordance with Section 01 00 10 - General Requirements and Section 23 05 03 - Mechanical Start-Up; supplemented as specified herein.
 - .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
 - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
 - .2 After starting pump, check for proper, safe operation.
 - .3 Check base for free-floating, no obstructions under base.
 - .4 Run-in pumps for 12 continuous hours minimum.
 - .5 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .6 Eliminate air from scroll casing.
 - .7 Adjust water flow rate through water-cooled bearings.
 - .8 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
 - .9 Adjust alignment of piping and conduit to ensure true flexibility.
 - .10 Eliminate cavitation, flashing and air entrainment.
 - .11 Adjust pump shaft seals, stuffing boxes, glands.
 - .12 Measure pressure drop across strainer when clean and with flow rates as finally set.
 - .13 Replace seals if pump used to degrease system or if pump used for temporary heat.
 - .14 Verify lubricating oil levels.

3.4 PERFORMANCE VERIFICATION (PV)

- .1 General:
 - .1 Verify performance in accordance with Section 01 00 10 - General Requirements and Section 23 08 13 - Performance Verification of HVAC Systems, supplemented as specified herein.
- .2 Verify that manufacturer's performance curves are accurate.
- .3 Ensure valves on pump suction and discharge provide tight shut-off.
- .4 Net Positive Suction Head (NPSH):
 - .1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.

- .2 Measure using procedures prescribed in Section 01 00 10 - General Requirements
- .3 Where procedures do not exist, discontinue PV, report to Consultant and await instructions.
- .5 Multiple Pump Installations - Series and Parallel:
 - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .7 Commissioning Reports: in accordance with Section 01 00 10 - General Requirements reports supplemented as specified herein. Reports to include:
 - .1 Record of points of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
 - .2 Use Report Forms specified in Section 01 00 10 - General Requirements: Report Forms and Schematics.
 - .3 Pump performance curves (family of curves).

3.5 TRAINING

- .1 In accordance with Section 01 00 10 - General Requirements: Training of O&M Personnel, supplemented as specified.
- .2 Provide instruction on equipment and systems operation and maintenance described in this section with the following minimum durations:
 - .1 Economizer, secondary heating water pumps, secondary chilled water pumps: 1 hour
 - .2 Boiler pumps, waste heat recovery system pumps, chiller primary pumps: 1 hour

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Refer to Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.2 REFERENCE STANDARDS

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .2 ASTM International (ASTM)
 - .1 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (SDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC water treatment systems and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for HVAC water treatment systems for incorporation into manual.
- .3 Include following:
 - .1 Log sheets as recommended by manufacturer.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect HVAC water treatment systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 CHEMICAL BYPASS / POT FEEDER

- .1 Welded carbon steel pressure vessel, 7.6L capacity, ball isolation flow control valves on inlet/outlet, supplied with wall mounting bracket.
- .2 Ratings: 1830 kPa @ 93°C
- .3 19mmØ inlet and outlet, 6mm vent/pressure relief port
- .4 19mmØ chemical fill port with 600mL polyethylene graduated funnel with integral 20 mesh strainer
- .5 Acceptable material: Axiom Industries CBF-2, SAI Model HP / STS 8L-POT.

2.2 SIDE STREAM FILTER PACKAGE

- .1 Hydronic filter package consisting of a ball isolation valve, filter assembly, sight glass, manual balancing valve, and brass nipples.
- .2 Filter
 - .1 304 stainless steel and brass, 1.5 L capacity, EPDM O-rings
 - .2 Cartridge filter: 65mmØ x 250mm, 10 micron.
 - .3 19mmØ inlet and outlet, 19mmØ drain valve with hose connection and cap.
 - .4 Flow rate: 3.79 to 37.9 L/min, 18.9 L/min optimal.
- .3 Sight glass
 - .1 Stainless steel or brass body, stainless steel ball cage, tempered borosilicate glass window, TPX ball.
 - .2 19mmØ inlet and outlet.
- .4 Balancing valve
 - .1 Manual type, brass construction, with integral air vent and memory stop.
 - .2 Valve to provide flow metering, flow balancing, and filter cartridge isolation.
- .5 Ratings: operating pressure to 860 kPa and 93°C
- .6 Acceptable material: Axiom Industries SFP-10

2.3 SIDE STREAM FILTER

- .1 304 stainless steel and brass, 1.5 L capacity, EPDM O-rings, supplied with wall mounting bracket.
- .2 Cartridge filter: 65mmØ x 250mm, 10 micron.
- .3 19mmØ inlet and outlet, 19mmØ drain valve with hose connection and cap.
- .4 Flow rate: 3.79 to 37.9 L/min, 18.9 L/min optimal.
- .5 Ratings: operating pressure to 860 kPa and 93°C
- .6 Acceptable material: Axiom Industries FH-10, SAI /STS FSS-34

2.4 SIGHT GLASS / FLOW INDICATOR

- .1 Stainless steel or brass body, stainless steel ball cage, tempered borosilicate glass window, TPX ball.

- .2 Ratings: operating pressure to 860 kPa and 93°C, capable of indicating flow at less than 1 GPM.
- .3 19mmØ inlet and outlet.
- .4 Acceptable material: Axiom Industries ASFI-075, Filter Mate Flow Indicator.

2.5 PACKAGED GLYCOL FILL SYSTEM

- .1 General: feeder compatible with glycol solutions of up to 60% concentration, unit to be completely assembled.
- .2 Tank
 - .1 Graduated polyethylene storage/mixing tank
 - .2 Tank to have removable top tank fill/access cover and minimum 50Ømm service opening.
 - .1 Cover to include integral supports/molding for pump, controls, and accessories as required.
- .3 Pump
 - .1 Pressure pump with internal protection, capable of running dry without damage.
 - .2 Capacity:
 - .1 See drawing schedule
 - .3 Power: 120v/1ph/60Hz.
- .4 Accessories
 - .1 EPDM diaphragm pneumatic pressure tank.
 - .2 Pressure regulating valve adjustable (70kPa or lower to 380 KPa) complete with pressure gauge
 - .3 Inlet Strainer
 - .4 Check valve
 - .5 Foot valve
 - .6 Diverter valve for purging air and agitating contents of storage tank.
 - .7 13mm x 900mm long flexible connection hose with check valve.
- .5 Control
 - .1 Packaged liquid tank monitor and pump control including:
 - .1 LED Visual low level alarm.
 - .2 2 stage audible low level alarm.
 - .3 Low level alarm contact.
 - .4 Low level motor cutoff.
 - .5 NEMA 1 enclosure
 - .6 Float type level sensors.
 - .7 Pressure switch control to maintain system pressure automatically.
 - .2 Acceptable material: Axiom Alarm Panel RIA10-1-SAA
- .6 Schedule: see drawings
- .7 Acceptable material: Axiom Industries SF or MF series

- .1 Acceptable alternates: STS Pelican, SAI

2.6 PROPYLENE GLYCOL

- .1 Factory premixed with demineralized distilled, deionized or reverse osmosis filtered water. Acceptable water quality to have trace quantities of chloride and sulfate within manufacturers specifications and total hardness of <100ppm CaCO₃.
- .2 Inhibited, low toxicity, high temperature propylene glycol with advanced inhibitor package for copper components, suitable for film temperatures to 160°C and freeze protection to -51°C
- .3 Virgin glycol only.
- .4 Solution concentration: 50% propylene glycol by weight.
- .5 Acceptable material: premixed Dow Chemicals DowFrost HD.

2.7 HYDRONIC PIPING AND EQUIPMENT DEGREASANT & DETERGENT

- .1 Refer to Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

2.8 FLUSH & CLEANING WATER

- .1 All water for system flush and clean to be clean local water. Adjust water to ensure pH to neutral.

2.9 TEST KITS

- .1 Provide standard water treatment test kit for as follows:
 - .1 Battery operated PH tester, range 0-14pH, resolution 0.2pH, accuracy 0.1pH:
 - .1 Acceptable Material: pH PockeTester model 2.
 - .2 Total Alkalinity test kit with 100 BCG MR tablets, 100 Phenolphthalein tablets, 50ml alkalinity titration reagent B, 1 titration tube and 1 plain pipe.
 - .1 Acceptable material: Merck.
 - .3 Phosphate test kit with all required reagents and pipette.
 - .1 Acceptable material: LaMotte model VM-12
 - .4 Glycol level tester, battery operated, vinyl housing, lighted with eyepiece.
 - .1 Acceptable Material: SAI MISCO-78C.
 - .5 Hardness test kit with direct reading titrator, indicator tablets and all required reagents.
 - .1 Acceptable material: LaMotte hardness test kit with Model PHT-DR titrator.
 - .6 Conductivity Meter, multi range with cell cups, self contained, temperature compensating, battery powered, 2% accuracy, 1% repeatability.
 - .1 Acceptable material: Myron.
- .2 Provide carrying case, reagents for chemicals, and additional specialized or supplementary equipment.

2.10 CHEMICALS

- .1 Provide 1 years supply.

2.11 TEST EQUIPMENT

- .1 Provide one set of test equipment for each system to verify performance.
- .2 Complete with carrying case, reagents for chemicals, specialized or supplementary equipment.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Install HVAC water treatment systems in accordance with ASME Boiler and Pressure Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.3 CLEANING, FLUSHING, AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems and Section 23 25 00 - HVAC Water Treatment Systems.

3.4 FILLING OF SYSTEM

- .1 Refill system with clean water adding water treatment as specified or with pre-mixed glycol solution.
 - .1 HW: water with corrosion inhibitors
 - .2 CW system: propylene glycol/water - 50/50

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 07 84 00 - Fire Stopping.

1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International (ASTM)
 - .1 ASTM A480/A480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
 - .3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Green Seal Environmental Standards (GS)
 - .1 GS-36-11, Standard for Adhesives for Commercial Use.
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-21, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-21, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
 - .3 IAQ Guideline for Occupied Buildings Under Construction 2007.
- .6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements and with manufacturer's written instructions.

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.5 NON-APPLICABLE SYSTEMS

- .1 Items described in this section are NOT applicable for the following systems:
 - .1 Chemical storage cabinet vent piping. Refer to Section 22 13 19 - PVC Process Piping.

Part 2 Products

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:
 - .1

Max Pressure Pa	SMACNA Seal Class
1000	A
750	B
500	C
125	Unsealed

- .2 Seal classification:
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.
 - .3 Class C: transverse joints and connections made air tight with sealant. Longitudinal seams unsealed.
 - .4 Unsealed seams and joints.

2.2 SEALANT

- .1 Sustainability Characteristics:
 - .1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .2 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants and SCAQMD Rule 1168
 - .3 Adhesives and sealants: VOC limit 250 g/L maximum to SCAQMD Rule 1168.
- .2 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
 - .1 Rectangular: centreline radius: 1 times width of duct.
 - .2 Round: smooth radius, centreline radius: 1 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 407 mm: with single thickness turning vanes.
 - .2 Over 407 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with 45 degrees entry on branch.
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
 - .1 as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Coordinate with 07 84 00 - Fire Stopping to ensure fire stopping materials and installation does not distort duct.

2.7 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to ASHRAE.
- .3 Joints: to ASHRAE. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.8 STAINLESS STEEL

- .1 To ASTM A480/A480M, Type 304.
- .2 Finish: number 4.
- .3 Thickness, fabrication and reinforcement: to ASHRAE.

- .4 Joints: to ASHRAE.

2.9 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
 - .1 Maximum size duct supported by strap hanger: 500.
 - .2 Hanger configuration: to ASHRAE.
 - .3 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE :
 - .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 GENERAL

- .1 Do work in accordance with ASHRAE, SMACNA and NFPA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Ensure diffuser is fully seated, Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with ASHRAE and SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with SMACNA

3.3 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Fresh air intake.
 - .2 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Solder or weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served.

- .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve and discharging to open funnel drain.

3.4 STAINLESS STEEL DUCT

- .1 Stainless steel ducting to be used for:
 - .1 Ducted fume hood E/A duct (F-FH-1/2/3)
- .2 All joints to be welded.

3.5 SEALING AND TAPING

- .1 Apply sealant in accordance with SMACNA and to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.
- .3 Schedule:
 - .1 SMACNA Seal Class B
 - .1 ERV-1/2 O/A and E/A ducting
 - .2 ERV-1/2 space R/A and washroom/janitor room E/A ducting
 - .3 ERV-1/2 S/A ducting to FCU , VAV boxes, and CVR dampers.
 - .4 Fume Extraction arm E/A duct (F-FH-5 system)
 - .2 SMACNA Seal Class C
 - .1 All FCU S/A and R/A ducting
 - .2 MAU-1 S/A ducting
 - .3 Cooling fan systems (F-C-1 & F-C-2) ducting
 - .4 Smudging exhaust fan systems (F-E-1 & F-E-2) ducting

3.6 LEAKAGE TESTS

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 Do not install additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .6 Complete test before performance insulation or concealment Work.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems

1.2 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air duct accessories from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material:

- .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m².

2.3 ACCESS DOORS IN DUCTS

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
 - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
 - .2 301 to 450 mm: four sash locks complete with safety chain.
 - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
 - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - .5 Hold open devices.

2.4 INSTRUMENT TEST

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.5 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

Part 3 Execution

3.1 INSTALLATION

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .2 Length of connection: 100 mm.
 - .3 Minimum distance between metal parts when system in operation: 75 mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:

- .1 Size:
 - .1 900 x 900 mm for person size entry.
 - .2 600 x 600 mm for servicing entry.
 - .3 300 x 300 mm for viewing.
 - .4 As indicated.
- .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Consultant.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems
- .3 Section 23 08 13 - Performance Verification of HVAC Systems

1.2 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-2013.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of packaging materials, padding, pallets, crates as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

1.6 NON-APPLICABLE SYSTEMS

- .1 Items described in this section are NOT applicable for the following systems:

- .1 Chemical storage cabinet vent piping. Refer to Section 22 13 19 - PVC Process Piping.

Part 2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height as indicated.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.3 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: as indicated.
- .4 Bearings: self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage: less than 20cfm/ft² (100L/s/m²) at 250 Pa.

Part 3 Execution

3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.
- .7 Corrections and adjustments conducted by Consultant.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems
- .3 Section 23 08 13 - Performance Verification of HVAC Systems
- .4 Section 23 33 00 - Air Duct Accessories.

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 ALUMINUM DAMPERS - INSULATED/THERMALLY BROKEN

- .1 Frame: extruded 6063T5 aluminum, 2.03 mm thick, 101.6 mm deep, insulated with Styrofoam on three sides for duct mounting and four sides for flanged mounting.
 - .1 Entire frame shall be thermally broken by means of polyurethane resin pockets complete with thermal cuts.
- .2 Blades: extruded 6063T5 aluminum, internally insulated with expanded polyurethane foam, thermally broken, minimum insulation value 0.4RSI.
- .3 Blade and Frame Seals: extruded silicone in integral slot within aluminum extrusions and mechanically fastened to prevent shrinkage and movement.
 - .1 Silicone shall be specially formulated silicone for reduced air leakage at extreme cold temperatures and must retain flexibility to -73°C.
- .4 Bearings: Celcon inner bearing, 11mm aluminum hexagon blade pin, polycarbonate outer bearing.
- .5 Linkage: frame side, aluminum and corrosion resistant zinc plated steel with slip proof cup-point trunnion screws. Blade linkage hardware to be installed out of air- stream.
- .6 Jack Shaft assemblies: to be provided for multiple damper installations.
- .7 Operating temperature range: -40°C to 100°C.
- .8 Leakage: 25 L/s/m² at 1 kPa differential static pressure at -40°C.
- .9 Pressure drop: full open 1200x1200 damper not to exceed 0.007 kPa at 5.08 m/s.
- .10 Certification: AMCA 511
- .11 Mounting: Flanged to duct.
- .12 Operator:
 - .1 To Section 25 30 02 - Field Control Devices
- .13 Schedule:
 - .1 Refer to drawings
- .14 Acceptable Material: TAMCO series 9000-BF-ECT thermally broken and insulated damper.
 - .1 Acceptable alternate: Nailor Industries

2.2 ALUMINUM DAMPERS - AIRFOIL

- .1 Frame: extruded 6063T5 aluminum, 2.03 mm thick, 101.6 mm deep
- .2 Blades: extruded 6063T5 aluminum
- .3 Blade and Frame Seals: extruded EPDM (blade) and TPE (frame) in integral slot within aluminum extrusions and mechanically fastened to prevent shrinkage and movement.
- .4 Bearings: Celcon inner bearing, 11mm aluminum hexagon blade pin, polycarbonate outer bearing.
- .5 Linkage: frame side, aluminum and corrosion resistant zinc plated steel with slip proof cup-point trunnion screws. Blade linkage hardware to be installed out of air- stream.
- .6 Jack Shaft assemblies: to be provided for multiple damper installations.

- .7 Operating temperature range: -40°C to 100°C.
- .8 Leakage: 52 L/s/m² at 1 kPa differential static pressure at -40°C.
- .9 Pressure drop: full open 1200x1200 damper not to exceed 0.004 kPa at 5.08 m/s.
- .10 Certification: AMCA 511
- .11 Mounting: Flanged to duct.
- .12 Operator:
 - .1 To Section 25 30 02 - Field Control Devices
- .13 Schedule:
 - .1 Refer to drawings
- .14 Acceptable Material: TAMCO series 1000 Airfoil damper.
 - .1 Acceptable alternate: Nailor Industries

2.3 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, centre pivoted, spring-assisted and counterweighted as required..

2.4 ALUMINUM DAMPERS - BACKDRAFT

- .1 Frame: extruded 6063-T5 aluminum, minimum 1.52 mm thick, 63.5 mm deep.
- .2 Blades: extruded 6063-T5 aluminum, minimum 1.52mm thick
- .3 Blade and Frame Seals: extruded silicone in integral slot within aluminum extrusions and mechanically fastened to prevent shrinkage and movement.
- .4 Bearings: 12.7 mm aluminum pivot points rotating on Celcon bearings.
- .5 Linkage: 6005-T6 aluminum alloy crank arms and 8.73mm linkage rods, corrosion resistant zinc plated steel with slip proof cup-point trunnion screws.
- .6 Operating temperature range: -40°C to 100°C.
- .7 Leakage: 57.8 L/s/m² at 250 Pa differential static pressure at -40°C.
- .8 Pressure drop: full open 610x610 damper not to exceed 0.189 kPa at 15.291 m/s
- .9 Certification: AMCA 511.
- .10 Mounting: Flanged to duct.
- .11 Schedule:
 - .1 Refer to drawings
- .12 Acceptable Material: TAMCO Series 7000 Medium Duty Backdraft Damper.

2.5 ALUMINUM DAMPERS - BACKDRAFT, COUNTERWEIGHTED

- .1 Frame: extruded 6063-T5 aluminum, minimum 1.52 mm thick, 63.5 mm deep.
- .2 Blades: extruded 6063-T5 aluminum, minimum 1.52mm thick
- .3 Counterweights: Fully adjustable aluminum (6061-T6) counterbalance weights shall be mounted on each blade, adjustability such that damper may be set to relieve air pressure differentials less than 3 Pa.

- .4 Blade and Frame Seals: extruded silicone in integral slot within aluminum extrusions and mechanically fastened to prevent shrinkage and movement.
- .5 Bearings: 12.7 mm aluminum pivot points rotating on Celcon bearings.
- .6 Linkage: 6005-T6 aluminum alloy crank arms and 8.73mm linkage rods, corrosion resistant zinc plated steel with slip proof cup-point trunnion screws.
- .7 Operating temperature range: -40°C to 100°C.
- .8 Leakage: 57.8 L/s/m² at 250 Pa differential static pressure at -40°C.
- .9 Pressure drop: full open 610x610 damper not to exceed 0.189 kPa at 15.291 m/s
- .10 Certification: AMCA 511.
- .11 Mounting: Flanged to duct.
- .12 Schedule:
 - .1 Refer to drawings
- .13 Acceptable Material: TAMCO Series 7000-CW Medium Duty Adjustable Counterweighted Backdraft Damper.

Part 3 Execution

3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Ensure dampers are observable and accessible.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 07 84 00 - Fire Stopping.
- .3 Section 23 08 13 - Performance Verification of HVAC Systems
- .4 Section 23 33 00 - Air Duct Accessories.

1.2 REFERENCE STANDARDS

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-21, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112-10, Standard Test Method of Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC-S112.2-07, Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.
 - .3 ULC-S505-1974, Standard for Fusible Links for Fire Protection Service.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for fire and smoke dampers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Operators.
 - .3 Fusible links.
 - .4 Design details of break-away joints.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for fire and smoke dampers for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Submit maintenance materials in accordance with Section 01 00 10 - General Requirements
 - .2 Provide:

- .1 6 fusible links of each type.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect fire and smoke dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B, listed, meet requirements of authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN/ULC-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
 - .1 Fire dampers: 1 hour fire rated unless otherwise indicated.
 - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: offset single damper, round or square; multi-blade hinged sized to maintain full duct cross section as indicated.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

- .10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Coordinate installation of fire stopping with Section 07 84 00 - Fire Stopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements

1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-12, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 2005.
- .4 Underwriters' Laboratories (UL)
 - .1 UL 181-2005, Standard for Factory-Made Air Ducts and Air Connectors.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110-2007, Standard Methods of Tests for Air Ducts.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect flexible ducts from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of crates, pallets, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC - UNINSULATED

- .1 Type 1: spiral wound flexible stainless steel, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC - INSULATED

- .1 Type 2: spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier and reinforced mylar/neoprene laminate jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.4 NON-METALLIC - UNINSULATED

- .1 Type 3: non-collapsible, coated aluminum foil mylar type, mechanically bonded to, and helically supported by, external steel wire, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.5 NON-METALLIC - INSULATED

- .1 Type 4: non-collapsible, coated aluminum foil/mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, 37 mm thick flexible mineral fibre thermal insulation with vapour barrier and reinforced mylar/neoprene laminate jacket, as indicated.

- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

Part 3 Execution

3.1 DUCT INSTALLATION

- .1 Install in accordance with: SMACNA.
- .2 Install flexible ducting only where explicitly noted on the drawings.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 [ASTM C423-02a](#), Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 [ASTM C916-85\(2001\)](#), Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 [ASTM C1071-00](#), Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .4 [ASTM C1338-00](#), Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .5 [ASTM G21-96\(2002\)](#), Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-21, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-21, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .3 North American Insulation Manufacturers Association (NAIMA)
 - .1 NAIMA AH116-5th Edition, Fibrous Glass Duct Construction Standards.
- .4 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA, HVAC Duct Construction Standards, Metal and Flexible-95 (Addendum No. 1, Nov 97).
 - .2 SMACNA IAQ Guideline for Occupied Buildings Under Construction-95.
- .5 Underwriter's Laboratories of Canada (ULC)
 - .1 [CAN/ULC-S102-03-EN](#), Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Submit product data in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements

- .2 Operation and Maintenance Data: submit operation and maintenance data for duct liners for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Protect on site stored or installed absorptive material from moisture damage.
- .3 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .4 Storage and Handling Requirements:
 - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect duct liners from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DUCT LINER

- .1 General:
 - .1 Mineral Fibre duct liner: air surface coated mat facing.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with [NFPA 90A](#).
 - .3 Recycled Content: EcoLogo certified.
 - .4 Fungi resistance: to [ASTM C1338](#).
- .2 Rigid:
 - .1 Use on flat surfaces where indicated.
 - .2 25 mm thick, to [ASTM C1071](#) Type 2, fibrous glass rigid board duct liner.
 - .3 Density: 48 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.76 (m² degrees C)/W for 25mm thickness when tested in accordance with [ASTM C177](#), at 24 degrees C mean temperature
 - .5 Maximum velocity on faced air side: 20.3 m/sec.
 - .6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to [ASTM C423](#)
 - .7 Recycled Content: EcoLogo certified.
 - .8 Acceptable Material: Knauf Liner E-M.
- .3 Flexible:
 - .1 Use on round or oval surfaces.
 - .2 25 mm thick, to [ASTM C1071](#) Type 1, fibrous glass blanket duct liner.
 - .3 Density: 24 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.74(m². degrees C)/W for 25mm thickness when tested in accordance with [ASTM C177](#), at 24 degrees C mean temperature.

- .5 Maximum velocity on coated air side: 30.5 m/sec.
- .6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to [ASTM C423](#)

2.2 ADHESIVE

- .1 Adhesive: to [NFPA 90A](#) and [NFPA 90B](#).
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degrees C to plus 93 degrees C.
- .3 Water-based fire retardant type.

2.3 FASTENERS

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

2.4 JOINT TAPE

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 SEALER

- .1 Meet requirements of [NFPA 90A](#).
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

Part 3 Execution

3.1 GENERAL

- .1 Do work in accordance with SMACNA HVAC Duct Construction Standard except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.

3.2 DUCT LINER

- .1 Install in accordance with manufacturer's recommendations, and as follows:
- .2 Fasten to interior sheet metal surface with 100% coverage of adhesive to ASTM C916
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres to compress duct liner sufficiently to hold it firmly in place.
 - .3 Spacing of mechanical fasteners in accordance with SMAC HVAC DCS .
- .3 In systems, where air velocities exceeds 20.3 m/s, install galvanized sheet metal noising to leading edges of duct liner.

3.3 JOINTS

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply 2 coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Consultant.
- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems
- .3 Section 23 05 03 - Mechanical Startup.
- .4 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .5 Section 23 08 13 - Performance Verification of HVAC Systems
- .6 Section 23 33 00 - Air Duct Accessories.
- .7 Section 22 13 19 - PVC Process Piping

1.2 REFERENCE STANDARDS

- .1 Where edition/year not noted, latest edition/year to be used.
- .2 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
 - .1 ANSI/AMCA Standard 204-05 - Standard Balance Quality and Vibration Levels for Fans
 - .2 ANSI/AMCA Standard 210-07, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .3 ANSI/AMCA Standard 300-2008, Reverberant Room Method for Sound Testing of Fans.
 - .4 ANSI/AMCA Standard 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 - .5 ANSI/AMCA Standard 500-D-12, Laboratory Methods of Testing Dampers for Rating
 - .6 ANSI/AMCA Standard 500-L-12, Laboratory Methods of Testing Louvers for Rating
- .3 Air Movement and Control Association (AMCA)
 - .1 99 - Standards Handbook
 - .2 200 - Publication, Air Systems
 - .3 201 - Publication, Fans and Systems
 - .4 202 - Publication, Troubleshooting
 - .5 203 - Publication, Field Performance Measurement of Fan Systems
 - .6 211 - Publication, Certified Ratings Program – Product Rating Manual for Fan Air Performance
 - .7 311 - Publication Certified Ratings Program – Product Rating Manual for Fan Sound Performance
 - .8 99-0401 - Classification for Spark Resistant Construction
 - .9 99-2408 - Operating Limits for Centrifugal Fans
- .4 American National Standards Institute (ANSI)

- .1 ANSI/AIHA/ASSE Z9.5 – Laboratory Ventilation
- .5 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 110-2016 – Method Of Testing Performance Of Laboratory Fume Hoods
- .6 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
 - .1 Chapter 45 - 2003 Handbook, HVAC Applications
 - .2 Chapter 7 - 2001 Fundamentals Handbook, Sound-Vibration
 - .3 Chapter 32 - 2001 Fundamentals Handbook, Duct Design
 - .4 Chapter 18 - 1992 HVAC System and Equipment Handbook, Fans
- .7 Canadian Standards Association (CSA International)
 - .1 CSA Z316.5-2020 – Fume hoods and associated exhaust systems
- .8 National Fire Protection Association (NFPA)
 - .1 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems
- .9 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 Medium Pressure Plenum Construction Standard
- .10 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
 - .1 MPI #18, Primer, Zinc Rich, Organic.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide:
 - .1 Fan performance curves showing point of operation (flow and static pressure), bhp and efficiency.
 - .2 Sound rating data at point of operation.
 - .3 Where applicable, nozzle velocity of exhaust fan, total exhaust flow, and discharge plume height at specified wind velocity.
 - .2 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
 - .2 Minimum performance achievable with variable speed controllers.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Submit in accordance with Section 01 00 10 - General Requirements
 - .1 Provide:

- .1 Matched sets of belts.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect HVAC fans from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of padding, pallets, crates, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
 - .2 Capacity: flow rate, static pressure, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
 - .3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99.
 - .4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300. Supply unit with ANSI/AMCA certified sound rating seal.
 - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA Standard 210. Supply unit with ANSI/AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

2.2 FANS GENERAL

- .1 Wheel
 - .1 Material: aluminum or composite

- .2 Non-overloading, backward inclined or mixed flow
- .3 Statically and dynamically balanced in accordance to AMCA Standard 204
- .4 The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.
- .2 Motors:
 - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
 - .2 Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
 - .3 Motor enclosures to be Open drip-proof (ODP) or Totally enclosed fan cooled (TEFC)
 - .4 AC Induction Motor
 - .1 Mounted on vibration isolators, out of the airstream
 - .2 Accessible for maintenance
 - .3 For use with variable frequency drives where indicated.
 - .5 Electronically Commutated Motor (ECM)
 - .1 Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable.
 - .2 Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
 - .3 Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
 - .4 Motor shall be a minimum of 85% efficient at all speeds.
 - .6 Sizes as specified.
- .3 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- .4 Factory primed before assembly in colour standard to manufacturer.
- .5 Scroll casing drains: as indicated.
- .6 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .7 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .8 Flexible connections: to Section 23 33 00 - Air Duct Accessories.
- .9 Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

2.3 SQUARE CENTRIFUGAL INLINE FANS

- .1 General:
 - .1 Applications include: supply, exhaust, return, or make-up air systems

- .2 Fan shall be suitable for in-line or 90 degree turn through fan applications
- .2 Wheel
 - .1 Per clause 2.2 Fans General.
- .3 Motor
 - .1 Per clause 2.2 Fans General. Use ECM motor where available.
- .4 Housing/Cabinet Construction: Square design constructed of heavy gauge galvanized steel, aluminum or painted steel
 - .1 Motor Cover: Constructed of galvanized steel, covers motor and drives for safety
- .5 Disconnect Switches
 - .1 NEMA rated: 1, 3R or 4
 - .2 Positive electrical shut-off
 - .3 Wired from fan motor to junction box installed within motor compartment.
- .6 Duct collar
 - .1 Square Duct Companion Flange: Inlet and outlet flat flange face allows fan to slide in and out of duct work, square design to provide a large discharge area.
- .7 Access Panel: Two-sided access panels, permit easy access to all internal components, located perpendicular to the motor mounting panel.
- .8 Accessories
 - .1 Isolation
 - .1 Neoprene/Rubber Mount: Type 2, (1/4 inch to 1/2 inch deflection), Steel top plate, base plate embedded in oil resistant neoprene, tapped hole in center.
 - .2 Housed Spring: Type 4B, (1 inch deflection), Steel Springs assembled into a telescoping housing.
 - .3 Restrained Spring Mount: Type 4A, (1 inch deflection), laterally stable, free standing springs assembled into steel housing.
 - .4 Sized to match the weight of each fan
- .9 Standard of Acceptance: Greenheck SQ series with Vari-Green motor, Penn Barry, Loren Cook

2.4 ROOF UPBLAST CENTRIFUGAL EXHAUST FANS

- .1 General:
 - .1 Discharge air directly away from the mounting surface
 - .2 Upblast fan shall be suitable for roof mounted or sidewall mounted applications
- .2 Wheel
 - .1 Per clause 2.2 Fans General.
- .3 Motor
 - .1 Per clause 2.2 Fans General. Use ECM motor where available.
- .4 Housing

-
- .1 Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable.
 - .2 Housing shall have a rigid internal support structure. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing. Windband to include an integral rolled bead for strength.
 - .3 Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable.
 - .4 Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb.
 - .5 Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
 - .6 Breather tube shall be 10 square inches in size for fresh air motor cooling and designed to allow wiring to be run through it.
 - .7 Motor Cover: Constructed of aluminum
 - .5 Disconnect Switches
 - .1 NEMA rated: 3R or 4
 - .2 Positive electrical shut-off
 - .3 Wired from fan motor to junction box installed within motor compartment.
 - .6 Drain Trough: Allows for one-point drainage of water, grease, and other residues
 - .7 Accessories
 - .1 Birdscreen: 13mm square mesh, galvanized or stainless steel.
 - .2 Roof Curbs
 - .1 Welded, straight sided curb with 2 inches of flashing flange and wood nailer. Mounted onto roof with fan.
 - .2 Material: Galvanized steel
 - .3 Insulation thickness: 38mm
 - .4 Flashing Flange: 50mm
 - .3 Curb extension
 - .1 Bolted access door and damper holding tray.
 - .2 Material: Galvanized steel
 - .4 Curb seal: Dense foam seal tape between the fan curb cap and the roof curb.
 - .5 Dampers
 - .1 Type: Motorized, refer to damper schedule on drawings.
 - .2 Galvanized frames with pre-punched mounting holes
 - .8 Hinge Base: Allows the fan to tilt away for access to wheel and ductwork for inspection and cleaning
 - .1 Aluminum hinges
 - .2 Hinges and restraint cables are mounted to a base (sleeve)
 - .9 Standard of Acceptance: Greenheck CUE series with Vari-Green motor, Penn Barry, Loren Cook

2.5 DIRECT DRIVE MIXED FLOW ROOD SUPPLY FANS

- .1 General:
 - .1 Intake (outside) air fan with intake hood suitable for mounting on a roof curb.
 - .2 Fan shall be suitable for 90 degree turn through fan to allow discharge down through roof.
- .2 Wheel
 - .1 Per clause 2.2 Fans General.
- .3 Motor
 - .1 Per clause 2.2 Fans General. Use ECM motor where available.
- .4 Housing
 - .1 Fan inlet cone to be aluminum. Composite material may be used if manufacturer's product sizing does not allow for aluminum.
 - .2 Arrangement to be horizontal intake with a bottom discharge.
 - .3 Constructed of heavy gauge galvanized steel with a removeable hood cover and side panels, leak resistant design.
 - .4 Housing frame to be constructed of structural steel with formed flanges. Lifting lugs shall be included on housing supports.
 - .5 Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
 - .6 Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable. Cap to include pre-punched mounting holes.
- .5 Disconnect Switches
 - .1 NEMA rated: 3R or 4
 - .2 Positive electrical shut-off
 - .3 Wired from fan motor to junction box installed within motor compartment.
- .6 Accessories
 - .1 Birdscreen: 13mm square mesh, galvanized or stainless steel.
 - .2 Inlet hood to have a 25mm washable aluminum filter.
 - .3 Roof Curbs
 - .1 Welded, straight sided curb with 2 inches of flashing flange and wood nailer. Mounted onto roof with fan.
 - .2 Material: Galvanized steel
 - .3 Insulation thickness: 50mm
 - .4 Flashing Flange: 50mm
 - .4 Curb extension
 - .1 Material: Galvanized steel
 - .5 Curb seal: Rubber seal between the fan and the roof curb.
 - .6 Duct adapter: fits over roof curb and supports the top of the duct, installed before fan set in place.

- .7 Finish: All exterior surfaces including roof curb and extension to have Permator coating
- .8 Standard of Acceptance: Greenheck KSQ series with Vari-Green motor, Penn Barry, Loren Cook

2.6 FUME HOOD EXHAUST FANS

- .1 General:
 - .1 Exhaust fume hood fan assembly to be a packaged High-Plume Laboratory Exhaust System.
 - .2 Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
 - .3 Each fan shall be direct drive.
 - .4 Each fan to be equipped with 316 stainless steel lifting lugs for corrosion resistance.
 - .5 Fasteners exposed to corrosive exhaust shall be stainless steel.
 - .6 Fan assembly shall be designed for a minimum of 125 MPH wind loading, without the use of guy wires.
- .2 Corrosion Resistant Coating
 - .1 All steel fan and system components (fan, nozzle, windband and plenum) shall be corrosion resistant coated with LabCoat™, a two part electrostatically applied and baked, sustainable, corrosion-resistant coating system. Standard finish color to be RAL 7023, concrete grey. All parts shall be cleaned and chemically prepared for coating using a multistage wash system which includes acid pickling to remove oxide, improving the coating bond to the substrate.
 - .2 The coating system shall not be less than a total thickness of 6 mils, shall not be affected by the UV component of sunlight (does not chalk), and have superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000 hour ASTM B117 Salt Spray Resistance.
- .3 Fan Housing and Outlet
 - .1 Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence. Fan housing shall be welded steel and meet specification section 2.15 for corrosion resistant coating. No uncoated metal fan parts shall be acceptable.
 - .2 A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM (30.48 m/s). Discharge nozzles shall be steel with corrosion resistant coating or chemical resistant medium density polyethylene with UV inhibitors to prevent chalking and have smooth interior surfaces. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
 - .3 Motor compartment shall be sealed from the contaminated airstream and have integral cooling vents to fan exterior housing to prevent heat build-up.
 - .4 Housing shall have a bolted and gasketed access panel allowing for inspection of impeller. Provide housing drain for removal of rain and condensation.
 - .5 Impeller, inlet cone and motor shall be removable in a single cartridge from the exterior of the fan housing without removal of the fan housing from plenum or roof curb.

-
- .4 Fan Impeller
 - .1 Fan impeller shall be centrifugal, backward curved, with laminar blade geometry and non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.
 - .2 Fan impeller shall be manufactured of aluminum (AMCA type B spark resistant) and coated with Hi Pro polyester resin.
 - .5 Fan bypass air plenum
 - .1 For variable volume systems, a bypass air plenum shall be provided. The plenum shall be equipped with a bypass air damper and intake air hood with bird screen for introducing outside air at roof level upstream of the fan. The plenum shall be constructed of fully welded steel and have the designated corrosion resistant coating. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.
 - .2 The bypass air dampers shall be opposed-blade design, and coated with up to 4 mils of Hi-Pro polyester resin, electrostatically applied and baked.
 - .3 Fan isolation damper of parallel blade design, either gravity backdraft or two position actuated, fabricated of steel or aluminum and coated with minimum 4 mils of Hi-Pro polyester resin, electrostatically applied and baked, shall be provided as shown on the project documents.
 - .6 Bypass air plenum curb
 - .1 The fan manufacturer shall supply a structural support curb for the plenum, of specified height, as shown on the drawings. The curb shall be fabricated of a minimum of 14 gauge of galvanized steel and structurally reinforced. The curb shall be insulated.
 - .2 When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.
 - .7 Fan motors and disconnect
 - .1 Motors shall be premium efficiency, standard NEMA frame, 1800 or 3600 RPM, Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor on line (sinewave) frequency. Motor shall be labeled for use with a VFD with 10:1 VT and 1.0 service factor. Motor shall be equipped with internal shaft grounding ring protect motor bearings from the shaft voltages.
 - .2 Motor bearings shall be sealed for life and require no lubrication maintenance. Motor bearings shall be sized for an L-10 life of no less than 100,000 hours in vertical shaft down application.
 - .3 A factory-mounted NEMA 4 disconnect switch shall be provided for each fan.
 - .8 Control system
 - .1 A PLC controller shall be provided with the fan for variable air volume control of the fume hood exhaust. The controller shall manage the isolation damper position, bypass air damper modulation, and fan speed modulation.
 - .1 Controller shall accept a 0-10V or 4-20mA signal from the associated fume hood air flow monitor / controller for modulation of the bypass damper.

- .2 Controller shall accept a remote enable/disable signal from the associated fume hood air flow monitor / controller.
- .3 Control strategy: Control bypass damper only (constant fan speed)
 - .1 Fan is kept at a constant speed, and only the bypass damper is modulated to maintain exhaust air flow required by the fume hood air flow monitor / controller to maintain fume hood face velocity. This strategy maintains a constant discharge velocity and effective plume height. The VFD component of the controls system is used for test and balance to meet design flow (L/s) and outlet velocity. The maximum and minimum fan speed is set to be the same.
 - .4 The controller shall be capable of BACnet IP and/or BACnet MS/TP network communication.
- .2 A VFD selected to match the fan motor shall be provided as part of the control package. The VFD shall be pre-programmed per the specific project requirements and shall interface directly with the controller. Manufacturer to be ABB or Danfoss.
- .9 Standard of Acceptance: Greenheck Vektor-H (direct drive) with bypass air plenum and Vektor System Control (VSC) Package.

2.7 CENTRIFUGAL CORROSION RESISTANCE HVAC BLOWERS

- .1 Housing:
 - .1 Material:
 - .1 Non-explosion proof: Constructed of strong (min. 4-5mm thickness) high-density UV treated Polypropylene for maximum corrosion resistance.
 - .2 Explosion proof: Constructed of strong (min. 4-5mm thickness) high-density Carbon Impregnated Polypropylene (CIP) Spark "A" compliant composite material for maximum corrosion resistance.
 - .2 Assembly: Constructed of one single seamless piece to completely avoid leakage. Split housings or welded housings are not acceptable. Metal in the housing air stream shall not be tolerated.
 - .3 Plate and Housing Mounting: Stainless-steel mounting hardware, supporting, and accessories.
 - .4 Discharge Orientation: Blower scroll housing shall be field rotatable to any of eight standard discharge positions. Provide blower with discharge positioned from factory in proper direction to minimize connected duct turns.
- .2 Impeller: forward curved type, polypropylene constructions, dynamically balanced.
 - .1 Configuration: Forward-curved type, available in clockwise (CW) or counterclockwise (CCW) rotation.
 - .2 Assembly / Material:
 - .1 Shall be electronically and dynamically balanced. Blower impeller/wheel shall be supplied with a keyed motor hub bushing and O-ring sealed hubcap made of Polypropylene to fully protect motor shaft end from corrosive air contact. Impeller/Wheel shall be suited for up to 3450 RPM.
 - .2 Constructed of strong (min. 4-5mm thickness) high-density UV treated Polypropylene composite material for maximum corrosion resistance.

- .3 Explosion proof (where required): Constructed of strong (min. 4-5mm thickness) high-density UV treated Carbon Impregnated Polypropylene (CIP) Spark "A" compliant composite material for maximum corrosion resistance.
- .3 Motor: Direct drive, TEFC, Totally enclosed, ULC listed.
 - .1 Shall be direct drive and of heavy-duty ball bearing type for continuous/inverter duty with voltage as specified.
 - .2 Shaft shall be electronically and dynamically balanced and selected for continuous operation at maximum rated fan speed of 3600 rpm. Airtight seals installed around shaft on drive side of the single-width blowers.
 - .3 Explosion proof (where required): Shall be explosion proof fan cooled (XPFC) IP 66 rated. Motor shall be Class I Group C and D, Class II Group F and G, Division I and Division II. Motor shall be UL and CSA approved. Motor shall be IEC Ex ATEX approved (International Standards for explosive atmospheres conformity).
- .4 Motor Support:
 - .1 Galvanized steel motor support stand with pickled black enamel coating and stainless-steel hardware.
- .5 Accessories:
 - .1 Flexible PVC reducers / couplings with stainless steel compression clamps.
 - .2 Disconnect Switch: 25 Amp rated, NEMA, Type 4X / IP 66.
 - .3 Vibration isolators: neoprene rubber isolators with zinc plated threads.
 - .4 Vertical Gravity PVC or Polypropylene Backdraft Damper.
 - .5 Fume extraction arm:
 - .1 General: Fume extraction arm with three adjustable composite friction joints and 360° rotation through two outermost joints.
 - .2 Materials:
 - .1 Tubes: anodized aluminum with a white electrophoretic deposition coating for fume extraction where corrosion resistance is required.
 - .2 Joints: Glass fiber reinforced polypropylene plastic bodies and axial locking rings, stainless steel axles, PA & EDS plastic adjustment knobs.
 - .3 Damper: anodized aluminum handle, stainless steel internal spring, polypropylene plastic / TPE damper blade
 - .4 Swivel: powder coated aluminum with glass fiber reinforced polypropylene bearings
 - .5 Duct connector: EPDM rubber
 - .6 Hood: metal
 - .3 Working radius: 1090mm
 - .4 Noise level: 58 dB(A) at 66 L/s
 - .5 Fume temperature: max 70°C
 - .6 Extraction arm diameter: 75mm
 - .7 Airflow: 31 to 71 L/s

- .8 Accessories: wall mounting bracket kit, ceiling cover plate
- .9 Standard of Acceptance: Nederman FX2 75 CHEM
- .6 Standard of Acceptance:
 - .1 Chemical storage cabinet exhaust fan: Plastec Ventilation PLASTECH series
 - .2 Fume extraction arm exhaust fan: Plastec Ventilation STORM series

Part 3 Execution

3.1 FAN INSTALLATION

- .1 Install fans plumb and level as indicated, complete with resilient mountings and flexible electrical leads.
- .2 Mounting
 - .1 Install units with clearances for service and maintenance.
 - .2 Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .3 Comply with requirements for vibration isolation and seismic-control devices specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- .3 Provide sheaves and belts required for final air balance.
- .4 Bearings and extension tubes to be easily accessible.
- .5 Access doors and access panels to be easily accessible.
- .6 Install ducts adjacent to fans to allow service and maintenance. Make final duct connections with flexible connectors in accordance with section 23 33 00 - Air Duct Accessories except as follows:
 - .1 Corrosion Resistant Blowers: flexible PVC connectors as supplied/recommended by the fan manufacturer.
- .7 Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain, roof drain, with pipe sizes matching the drain connection.

3.2 START-UP

- .1 In accordance with section 23 05 03 - Mechanical Start-Up as supplemented herein.
- .2 Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- .3 Verify that cleaning and adjusting are complete.
- .4 Direct-drive fans: verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems
- .3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .4 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.
- .6 Section 23 08 13 - Performance Verification of HVAC Systems
- .7 Section 23 31 14 - Metal Ducts - Low Pressure to 500 Pa
- .8 Section 23 33 14 - Dampers - Balancing

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .2 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 International Organization of Standardization (ISO)
 - .1 ISO 3741-2001, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.
- .3 Underwriter's Laboratories (UL)
 - .1 UL 181-2003, Factory-Made Air Ducts and Air Connectors.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 00 10 - General Requirements. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 00 10 - General Requirements
 - .2 Indicate the following:
 - .1 Capacity
 - .2 Pressure drop
 - .3 Noise rating
 - .4 Include discharge and radiated sound power level schedules with shop drawings, for each of second through sixth octave bands and inlet pressures of 250 Pa to 1000 Pa.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 00 10 - General Requirements
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 PERFORMANCE CRITERIA

- .1 At inlet velocity of 10 m/s, pressure loss across the assembly shall not exceed 100Pa.
- .2 Casing leakage shall not exceed 2% design flow at rated internal pressure.
- .3 Air leakage across primary air valve damper shall not exceed 2% of nominal catalogue rating in the fully closed position at 3 inches inlet static pressure, when tested in accordance with ASHRAE 130.

2.2 MANUFACTURED UNITS

- .1 Terminal units of the same type to be product of one manufacturer.

2.3 ELECTRONIC VARIABLE VOLUME BOXES

- .1 Terminal unit to be CSA certified.
- .2 Assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum
- .3 At inlet velocity of 10 m/s, differential static pressure not to exceed 25 Pa.
- .4 Sound ratings of assembly not to exceed 40 NC at 125 Pa.
- .5 Complete with:
 - .1 Operator and controller:
 - .1 Operator to be electronic. Controller to be digital based unitary controller as per EMCS and incorporated as noted into EMCS network. Controller to meet all requirements for full BACNet functionality as required by EMCS network.
 - .2 Electronic control package to be calibrated and set at factory. Features to accommodate field calibration and readjustment of air volume settings.
 - .3 Signals between temperature sensing device, velocity controller, pressure sensor, velocity sensor and damper actuator to be analogue as indicated. Shielded or twisted wire requirements is not acceptable.
 - .4 Factory installed 20 VA transformer, 115 V to 24 V. Power consumption of terminal not to exceed 15 VA.
 - .2 Sound attenuator: as specified in Section 23 32 48 - Acoustical Air Plenums.
- .6 Gauge taps for balancing with standard pressure gauge.

- .7 Casing: constructed of 22 gauge galvanized steel, internally lined with 25 mm. 0.7 kg density fibrous glass, to ANSI/NFPA 90A. Mount control components inside protective metal shroud.
- .8 Air velocity sensor to be pitot rack as standard to manufacturer.
- .9 Damper: heavy gauge steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.
- .10 Schedule: as per drawing schedule for sizes and capacity
- .11 Acceptable material:
 - .1 Outside / Supply air: Price Industries SDV Series, Nailor Industries 3100 series
 - .2 Exhaust / Return air: Price Industries SDE Series, Nailor Industries 30X series

2.4 CONSTANT AIR FLOW REGULATOR

- .1 Regulator shall solely operate on duct pressure and require no external power supply. Each regulator shall be pre-set and factory calibrated, requiring no field adjustment to the airflows as indicated on the schedule, and shall be rated for use in air temperatures ranging from -32° to 60°C.
- .2 Constant Airflow Regulators shall be capable of maintaining constant airflow within +/- 10% of scheduled flow rates (15% for units 25 l/s or less). Regulators shall be provided as an assembly consisting of a 94V-0 UL plastic body housed within a round sleeve for mounting in round duct. Each round sleeve must be fitted with a lip gasket to ensure perimeter air tightness with the interior surface of the duct. All regulators must be classified per UL 2043 and carry the UL mark indicating compliance. All Constant Airflow Regulators will require no maintenance and must be warranted for a period of no less than five years.
- .3 Schedule: as per drawing schedule for sizes and capacity
- .4 Acceptable material: American Aldes Ventilation Corporation Model CAR-II, Nailor Industries Model CVR

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of ductwork, drywall or suspended ceiling.
- .3 Install with a minimum of four duct diameters of straight inlet duct, same size as inlet. Do not use flexible inlet ducting for inlet or discharge from the unit.
- .4 Locate controls, dampers and access panels for easy access.
- .5 Mounting hardware shall be supplied by the installing contractor.
- .6 Provide each unit with shut-off valves on supply and return connections.

- .7 Threaded rod, or aircraft wire may be used to suspend the units from the building structure.
- .8 Proper rigging practice must be observed when mounting beams with aircraft wire or cable.
- .9 Aircraft wire must be rated at a minimum 75kg (165lbs) breaking strength. Minimum cable thickness shall be 1.2 (3/64")
- .10 Coordinate installation with work of other trades to achieve a neat and professional installation.
- .11 Use AFV (Air flow valves) where indicated on drawings to set duct branch air flows.
- .12 Calibrate and test boxes with controller to VAV box manufacturers and EMCS contractor standards prior to installation.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 00 10 - General Requirements
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 00 10 - General Requirements
 - .2 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GENERAL

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .2 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames where set into plaster or gypsum board.
 - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators.
- .4 Colour: as indicated.

2.3 MANUFACTURED UNITS

- .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.
- .2 Acceptable material: as per drawing schedules.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturers instructions.
- .2 Install with stainless steel screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .2 National Fire Protection Association (NFPA)
- .3 National Research Council Canada (NRC)
 - .1 National Building Code of Canada 2020 (NBC).
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .5 Society of Automotive Engineers (SAE)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for louvers, intakes and vents and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Pressure drop.
 - .2 Face area.
 - .3 Free area.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect louvers, intakes and vents from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 FIXED LOUVRES - ALUMINUM

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
- .4 Frame, head, sill and jamb: 150 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.
- .5 Mullions: at 1500 mm maximum centres.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 13mm X 13 mm mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .8 Finish: anodized clear. Colour: to Consultant's approval.
- .9 Acceptable material: Price DE635
 - .1 Acceptable alternate: Nailor

Part 3 Execution

3.1 INSTALLATION

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems

1.2 REFERENCES

- .1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)
- .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):
 - .1 ANSI/ASHRAE 52-1976, "Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter".
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-115.10-M90 Filters, Air, Disposable, for Removal of Particulate Matter from Ventilating Systems.
 - .2 CAN/CGSB-115.18-M85 Filter, Air Extended Area Panel Type, Medium Efficiency.
- .4 Underwriters Laboratories of Canada:
 - .1 ULC-S111-M95, "Fire Tests for Air Filter Units".

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawing and product data in accordance with Section 01 00 10 - General Requirements
- .2 Indicate the following:
 - .1 Filter media.
 - .2 Filter racks and housings.
 - .3 Filter gauges.

1.4 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 00 10 - General Requirements. Include:
 - .1 Two complete sets of filter cartridges or sets of filter media for each filter or filter bank in addition to final operating set.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

1.5 CERTIFICATION OF RATINGS

- .1 Cataloged or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 GENERAL

- .1 Media: suitable for air at 100% RH and air temperatures between minus -40°C and 50°C.
- .2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated and as noted on drawings.
- .3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

2.2 ACCESSORIES

- .1 Holding frames: permanent "T" section construction of galvanized steel, 1.6 mm thick, except where specified otherwise.
- .2 Seals: to ensure leak proof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through doors/panels on each side.

2.3 PRE-FILTERS

- .1 Application:
 - .1 CF-1 O/A intake.
 - .2 CF-2 O/A intake.
 - .3 As indicated in other Sections and on the drawings.
- .2 Media: disposable preformed fibrous glass, synthetic media cartridge.
- .3 Media enclosing frame: galvanized steel with bracing.
- .4 Media support: welded wire grid.
- .5 Efficiency: 35% to ANSI/ASHRAE 52-1976 and MERV 7 to ASHRAE 52.2-1999.
- .6 Fire rated: to CAN4-S111.
- .7 Acceptable material: Camfil Farr 30-30.

2.4 FILTER GAUGES

- .1 Exception: for general use only. Not for use with HEPA filters.
- .2 Provide magnehelic gauges.
- .3 Magnehelic gauges to be accurate to +/-2% of full range.
- .4 Sensing probes and shut off valves to be provided for each gauge.
- .5 One gauge to be provided for each filter bank unless otherwise noted.

2.5 FINAL FILTER

- .1 Application:
 - .1 As indicated in other Sections and on the drawings.
- .2 Media: disposable preformed fibrous glass, synthetic media cartridge.
- .3 Media enclosing frame: galvanized steel with bracing.
- .4 Media support: welded wire grid.

- .5 Efficiency, as indicated:
 - .1 MERV 8 to ASHRAE 52.2
 - .2 MERV 13 to ASHRAE 52.2
- .6 Thickness: 50mm
- .7 Fire Rated: to CAN4-S11/UL Class 2
- .8 Acceptable material:
 - .1 MERV 8: Camfil Aeropleat III
 - .2 MERV 13: AP-Thirteen.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

3.2 REPLACEMENT MEDIA

- .1 Replace all media with new upon acceptance.
- .2 Filter media to be new and clean, as indicated by pressure gauge, at time of acceptance.

3.3 FILTER GAUGES

- .1 Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.
- .2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This section includes:
 - .1 Chimney and breeching for the Flue Gas Economizer system installed in the existing University Energy Center. The products of this section are not for the electric boilers installed within the building's Mechanical Room.

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 57 01 - Flue Gas Economizer

1.3 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .2 Underwriters' Laboratories of Canada (ULC)

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for chimneys and stacks and include product characteristics, performance criteria, physical size, finish and limitations.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial/Territorial regulations.
- .2 Certifications:
 - .1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect chimneys and stacks from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 PRESSURE CHIMNEY & BREECHING

- .1 General: factory built sectional, prefabricated, double wall with insulation, mated fittings and couplings, suitable for natural draft appliances and pressure and force draft appliances.
- .2 Approvals: ULC labelled, minimum 249°C rated
- .3 Seal: primary gas seal graphite gasket factor installed to inner liner.
- .4 Insulation: 50mm thickness high temperature mineral wool insulation.
- .5 Liner: type 304 stainless steel or AL29-4C stainless steel.
- .6 Shell: type 304 stainless steel or type 441 stainless steel.
- .7 Couplings: mated couplings with collar.
- .8 Fittings for each chimney:
 - .1 Base lateral tee with cap and drain.
 - .2 Rain cap
 - .3 Roof penetration thimble
 - .4 Roof flashing, collar and roof brace.
 - .5 Base and intermediate supports as required.
- .9 Acceptable material: Security Chimney CIX or SSID.
 - .1 These are the only acceptable products to ensure compatibility with the existing Energy Center boiler chimneys which are Security Chimney SSID-12.

Part 3 Execution

3.1 INSTALLATION - GENERAL

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Suspend breeching at 1.5 m centres and at each joint.
- .3 Support chimneys at bottom, roof and intermediate levels as indicated.
- .4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.
- .5 Install flashings on chimneys penetrating roofs, as indicated.
- .6 Install rain caps and cleanouts, as indicated.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems
- .3 Section 23 08 13 - Performance Verification of HVAC Systems

1.2 REFERENCE STANDARDS

- .1 American Boiler Manufacturers Association (ABMA)
- .2 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .3 CSA Group (CSA)
 - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.
- .4 Electrical and Electronic Manufacturers Association of Canada (EEMAC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heating boilers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 General arrangement showing terminal points, instrumentation test connections.
 - .2 Clearances for operation, maintenance, servicing, element cleaning, element replacement.
 - .3 Foundations with loadings, anchor bolt arrangements.
 - .4 Piping hook-ups.
 - .5 Equipment electrical drawings.
 - .6 Heating elements and controls.
 - .7 All miscellaneous equipment.
 - .2 Engineering data to include:
 - .1 Radiant heat loss at 100% design capacity.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for heating boilers for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra materials:
 - .1 Submit maintenance materials in accordance with Section 01 00 10 - General Requirements
 - .1 Special tools for burners, access opening, handholes and Operation and Maintenance.
 - .2 Spare parts for 1 year of operation.
 - .3 Other materials as recommended by boiler manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect boiler and equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of padding, pallets, crates, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 GENERAL

- .1 Packaged boiler:
 - .1 Complete with heating elements and necessary accessories and controls.
 - .2 Factory tested at rated capacity to, and bearing seal or nameplate certifying compliance with applicable standards.
 - .3 Ready for attachment to piping, electrical power, controls, flue gases exhaust.
 - .4 Designed and constructed to ASME Boiler and Pressure vessel Code.
 - .5 CRN (Canadian Registration Number), to CSA B51.
 - .6 Boiler package to bear ULC label.
- .2 Performance:
 - .1 As indicated on drawing schedules
- .3 Electrical:
 - .1 Power: as required and indicated on drawing schedules.
 - .2 Controls: Provide integral controls transformer as required.
 - .3 Electrical components: CSA approved.

- .4 Controls: factory wired. Enclosed in EEMAC 1 steel cabinet.
- .5 Thermal insulation:
 - .1 50 mm thick mineral fibre. Seal insulation at handholes, access opening, piping connections with insulating cement or asphaltic paint. Finish with heat resisting paint.
- .6 Jackets: heavy gauge metal, finished with heat resisting paint.
- .7 Mounting:
 - .1 Structural steel base, lifting lugs.
- .8 Anchor bolts and templates:
 - .1 Supply for installation by other Divisions. Anchor bolts to be sized to manufacturer's recommendations.
- .9 Trial usage:
 - .1 Consultant and Owner may use boilers for test purposes prior to acceptance and commencement of warranty period.
 - .2 Supply labour, materials and instruments required for tests.
- .10 Temporary use by contractor:
 - .1 Contractor may use boilers only after written approval from Consultant and Owner.
 - .1 Building hydronic systems boiler connected to must be fully flushed, cleaned, and ready for permanent use.
 - .2 Monitor and record performance continuously. Keep log of maintenance activities carried out.
 - .3 Refurbish to as-new condition before final inspection and acceptance.

2.2 ELECTRIC BOILER

- .1 Immersion resistance Incoloy type heating elements, low watt density, replaceable without special tools.
- .2 Boiler assembly to include:
 - .1 Control cabinet.
 - .2 Terminal blocks.
 - .3 Fuses: High Rupture Capacity (HRC) form 1:
 - .1 Heating elements.
 - .2 Primary of control circuit transformer.
 - .4 Pilot light for each step of heating elements.
 - .5 Pilot light for low water or high pressure/temperature.
 - .6 Manual on-off control circuit switch and "power on" pilot light.
- .3 Controls:
 - .1 Water temperature regulated by sequencing step controller with sensors operating between two adjustable set points operates magnetic contactors to energize heating elements.
 - .2 High limit control to de-energize heating elements at 80 degrees C.

2.3 AUXILIARIES

- .1 Provide auxiliaries for each boiler and to meet ASME requirements.
- .2 Hot water boilers:
 - .1 Relief valves: ASME rated, set at 310 kPa, to release entire boiler capacity.
 - .2 Pressure gauge: 90 mm diameter complete with shut-off cock.
 - .3 Thermometer: 115 mm diameter range 10 to 150 degrees C.
 - .4 Low water cut-off: with visual and audible alarms.
 - .5 Auxiliary low water cut-off: with separate cold water connection to boiler.
 - .6 Isolating gate valves: on supply and return connections.
 - .7 Drain valve: NPS 2.
 - .8 Stack thermometer: range 65 to 400 degrees C.
 - .9 Outdoor controller: to reset operating temperature controller.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Install in accordance with ASME Boiler and Pressure Vessels Code, regulations of Territory having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .4 Install boilers on a 100 mm concrete housekeeping pad and level, as required.
- .5 Do not deviate from required service and maintenance clearances as required by code.
- .6 Mount unit level using specified vibration isolation in Section 23 05 48 Vibration and seismic controls for HVAC.
- .7 Pipe individually each relief valve and air vents on hot water boilers to floor drain.
- .8 Start-up procedures shall include boil out with phosphate free chemical as directed by the manufacturer.
- .9 Connect appropriate electrical power to the boiler.
- .10 Coordinate with Division 26 for installation of emergency shut off switch for each boiler located outside near boiler room door.
- .11 The complete installation of boiler shall be compliant with the Boiler and Pressure Vessel Act and shall meet the acceptance of the authority having jurisdiction.
- .12 Test reports to be submitted for review and inclusion in maintenance manuals.

3.3 MOUNTINGS AND ACCESSORIES

- .1 Safety valves and relief valves:
 - .1 Run separate discharge from each valve.
 - .2 Terminate discharge pipe as indicated.
 - .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems
- .3 Section 23 08 13 - Performance Verification of HVAC Systems

1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code, 2010.
- .2 CSA Group (CSA)
 - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heat exchangers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Shop drawings to indicate project layout, including layout and dimensions of heat exchangers and system.
 - .1 Indicate manufacturer's recommended clearances for cleaning and maintenance.
 - .2 Include manufacturer's calculation sheet for heat exchanger selection.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for heat exchangers for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Submit in accordance with Section 01 00 10 - General Requirements
 - .1 Supply following spare parts:
 - .1 Head gaskets: 1.
 - .2 Supply additional spare parts in accordance with manufacturer's recommendations.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect heat exchangers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse or recycling of crates, packaging materials pallets, padding, as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 PLATE HEAT EXCHANGER

- .1 Designed, constructed and tested in with accordance CSA B51 and provincial pressure vessel regulations.
- .2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
- .3 Plates: type 316 stainless steel.
- .4 Gaskets: neoprene.
- .5 Piping connections: to suit required flow rate
- .6 Capacity: refer to drawing schedule
- .7 Temperatures: refer to drawing schedule
- .8 Flow: refer to drawing schedule
- .9 Fluids: refer to drawing schedule
- .10 Pressure Drop:
 - .1 Primary: 20 kPa (max)
 - .2 Secondary: 20 kPa (max)
- .11 Working Pressure: 3100 kPa
- .12 Schedule: See drawings
- .13 Acceptable Material: Kelvion, WTT America, Taco, Armstrong

2.2 BRAZED PLATE HEAT EXCHANGER

- .1 The heat exchanger shall be brazed plate construction, consisting of stainless steel plates, embossed with a specific heat transfer surface.
 - .1 Plates: embossed 316L stainless steel.
 - .2 Brazing: vacuum brazed pure copper.
 - .3 CSA/ULC listed.
 - .4 Working Pressure: 3100 kPa
 - .5 Test Pressure: 4995 kPa.
- .2 Connections: to suit required flow rate

- .3 Capacity: As per drawing schedule
- .4 Temperatures:
 - .1 As per drawing schedule
- .5 Flow: As per drawing schedule
- .6 Pressure Drop:
 - .1 Primary: 35 kPa (max)
 - .2 Secondary: 35 kPa (max)
- .7 Schedule: see drawings
- .8 Acceptable Material: Kelvion, WTT America

Part 3 Execution

3.1 INSTALLATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 General: install level and firmly anchored to supports in accordance with manufacturer's recommendations.
- .3 Plate exchangers: install in accordance with manufacturer's recommendations.

3.2 APPURTENANCES

- .1 Install with hose bib drain valve, safety relief valve and other accessories as indicated.
- .2 Install thermometer wells with thermometers on inlet and outlet of primary and secondary side.
- .3 Install pressure gauges on inlet and outlet of primary and secondary side.

3.3 SYSTEM START-UP

- .1 General: perform start-up operations in accordance with Section 01 00 10 - General Requirements and Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, supplemented as specified herein.
- .2 Check heater for cleanliness on primary and secondary sides.
- .3 Check water treatment system is complete, operational and correct treatment is being applied.
- .4 Check installation, settings, operation of relief valves and safety valves.
- .5 Check installation, location, settings and operation of operating, limit and safety controls.
- .6 Check supports, seismic restraint systems.
- .7 General: perform performance verification in accordance with Section 01 00 10 - General Requirements and Section 23 08 13 - Performance Verification of HVAC Systems, supplemented as specified.
- .8 Timing: only after TAB of hydronic systems have been successfully completed.
- .9 Primary side:
 - .1 Control valve: verify proper operation without binding, slack in components.

- .2 Primary side:
 - .1 Measure flow rate, pressure drop and water temperature at heater inlet and outlet.
 - .2 Verify installation and operation of air elimination devices.
- .3 Calculate heat transfer from primary and secondary sides.
- .4 Simulate heating water temperature schedule and repeat above procedures.
- .5 Verify settings, operation, safe discharge from safety valves and relief valves.
- .6 Verify settings, operation of operating, limit and safety controls and alarms.
- .7 Reports:
 - .1 In accordance with Section 01 00 10 - General Requirements: Reports, supplemented as specified herein.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by heat exchanger installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 79 00.13 - Demonstration and Training for Building Commissioning
- .2 Section 01 00 10 - General Requirements
- .3 Section 23 05 00 - Common Work Results for HVAC
- .4 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems
- .5 Section 23 08 13 - Performance Verification of HVAC Systems
- .6 Section 23 34 00 - HVAC Fans
- .7 Section 23 57 00 - Heat Exchangers for HVAC
- .8 Section 23 82 16 - Air Coils

1.2 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code, 2010.
- .2 CSA Group (CSA)
 - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.
- .3 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .4 Underwriters' Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heat exchangers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Shop drawings to indicate project layout, including layout and dimensions of heat exchangers and system.
 - .1 Indicate manufacturer's recommended clearances for cleaning and maintenance.
 - .2 Include manufacturer's calculation sheet for heat exchanger selection.
- .4 Manufacturers Reports:
 - .1 Manufacturer's Field Reports: submit manufacturer's written reports within 5 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements

- .2 Operation and Maintenance Data: submit operation and maintenance data for flue gas economizers for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Submit in accordance with Section 01 00 10 - General Requirements
 - .1 Supply additional spare parts in accordance with manufacturer's recommendations.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse or recycling of crates, packaging materials pallets, padding, as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

1.7 WARRANTY

- .1 For Work of this Section (23 57 01 Flue Gas Economizer), 12 months warranty period shall commence at completion of equipment start-up by system manufacturer technician.
- .2 Provide a full parts warranty for one year from start-up.

Part 2 Products

2.1 FLUE GAS ECONOMIZER

- .1 Manufacturer must be able to show they have successfully completed at minimum 50 installations of a similar product within Canada and must be able to show major components are manufactured within Canada.
- .2 General
 - .1 Factory assembled, modular, watertube, forced circulation condensing heat recovery system designed to heat plant district heating water through the recovery of both sensible and latent heat from boiler exhaust gas.
 - .2 The heat exchanger shall be suitable for condensing heat recovery from No.2 fuel oil flue gasses and shall use appropriate corrosion resistant materials and/or appropriate corrosion protection coatings for the increase corrosivity of this condensing application.
 - .3 The heat exchanger shall be capable of providing 211.4 kW of heat utilizing 3667 kg/hr of boiler flue gasses at 177°C. For this heat output / flue gas flow

rate/temperature the heat exchanger shall be capable of providing heating water at the following conditions:

- .1 Fluid flow of 2.20 L/s and entering and leaving water temperatures of 40°C to 63°C respectively
- .2 Fluid flow of 2.41 L/s and entering and leaving water temperatures of 40°C to 60°C respectively
- .3 The system shall be capable of utilizing flue gases from all five (5) of the existing fuel oil boilers installed in the Energy Center. Performance and available flue gas flow rate is based on a maximum of three (3) of the boilers operating simultaneously.
- .4 Heat exchanger module
 - .1 The heat exchanger shall be made of at minimum 4 sections with flanges and gaskets for bolting together and shall have a separate support stand.
 - .2 Heat exchanger modules to use a staggered tube arrangement that has been selected to provide sufficient draft loss for a given cross sectional area and tube pitch allowing a more compact design. Each module shall be completely drainable.
 - .1 Tubes shall be 1" OD stainless steel with solid aluminum fins at a density of 5 fins per inch. Fins shall have a heresite coating for corrosion protection.
 - .3 Heat exchanger modules framing to be stainless steel or shall have a heresite coating for corrosion protection where exposed to flue gases.
 - .4 The module shall have the flue gases enter the top of the unit and flow vertically downwards across the heat recovery core and exit out the bottom of the unit.
 - .5 Each module shall have a water washdown system installed and a solenoid valve for activation.
 - .6 All modules to connect to a common supply water header and a common return water header. The supply header shall be at the top of the unit and the return header at the bottom such that the water/flue gasses are in a counter flow arrangement.
 - .1 Provide temperature and pressure indicators on each of the headers, a thermal relief valve on the supply header, and a drain valve on the return header.
 - .7 A carbon steel support stand shall be provided for the heat exchanger module. Stand to have a zinc oxide primer and black epoxy paint coating.
 - .8 An steel inlet transition to the heat exchanger module from a 610Ømm flue shall be provided. Coordinate orientation and flue tie in with mechanical drawings for system.
 - .9 A FRP outlet transition to the heat exchanger module to a 610Ømm flue shall be provided. Coordinate orientation and flue tie in with mechanical drawings for system.
 - .1 FRP is required due to the corrosivity of the condensate and to ensure no leaks of flue gasses occur.
- .5 Controller

-
- .1 A control panel shall be provided with the unit. The controller shall include a color touch screen display and provide status information and allow for adjustment of setpoints. The controller shall provide alarm indication and signaling.
 - .2 The PLC controller shall have the following devices and inputs and outputs for:
 - .1 Input: Boiler enabled and modulation signals
 - .2 Input: Flue gas temperatures from the existing boiler chimneys
 - .3 Output: Take-off dampers position
 - .4 Input: Take-off dampers feedback
 - .5 Input: Flue gas temperatures from downstream of feedback dampers.
 - .6 Input: Flue gas temperature at the inlet to and outlet from the heat exchanger
 - .7 Input: Heating water inlet/outlet temperatures.
 - .8 Input: Water flow meter
 - .9 Output: Water bypass control valve
 - .10 Output: System fan enable and VFD modulation signals
 - .11 Output: Washdown system solenoid valves
 - .12 BACnet communication module for interfacing with existing Energy Center BMS system.
 - .3 The controller shall control the draft fan speed and boiler flue damper positions.
 - .4 The controller shall report the instantaneous BTU/hr reading and include a BTU totalizer.
 - .5 Control panel to include:
 - .1 PLC and display
 - .2 Power on/off switch
 - .3 Start/stop switch
 - .4 Emergency stop switch
 - .6 Display to include:
 - .1 Gas and liquid temperatures
 - .2 Liquid flow
 - .3 Fan signal %
 - .4 Damper positions %
 - .5 Equipment firing/steaming rates (if signals available)
 - .6 Btu/hr instantaneous reading
 - .7 Btu Totalizer
 - .8 System status
 - .9 Alarm conditions & history
 - .7 Acceptable material
 - .1 PLC: Siemens S7-1200 series
 - .2 Display: Siemens TP-900 Comfort
 - .6 Duct/flue accessories

- .1 Refer to Section 23 51 00 - Breechings, Chimneys and Stacks for requirements as supplemented herein.
- .2 New tees shall be provided for the boiler chimneys/flue for connection to the economizer. Tees shall be compatible with the existing chimney/flues.
- .3 High temperature control dampers shall be provided at the connection to each boiler chimney for isolation when the boiler is not firing. Dampers to be provided with electric actuators and include end switches for position feedback.
- .4 New flues from each isolation damper to the blower, from the blower to the economizer, and from the economizer through the roof. Refer to the chimneys and breeching sections below for requirements.
- .7 Approvals: ASME Boiler & Pressure Vessel Code Section VIII Division I
- .8 Standard of Acceptance: Combustion & Energy Systems ConDex condensing heat recovery system

2.2 FORCE DRAFT FAN (UTILITY BLOWER)

- .1 An industrial blower suitable for high temperature gases shall be provided to force flue gases through the heat exchanger core. The fan will come complete with a flanged inlet and outlet, access door, housing drain, and belt guard.
- .2 The fan will have a 20 HP, 1800 RPM TEFC, high efficiency motor and will include a VFD drive. Power for the motor will be 600V/3Ø/60Hz.
- .3 The fan to be separate from the FGE for remote mounting
- .4 Fan discharge to be vertical.
- .5 A fan inlet box shall be provided to minimize the fan footprint.
- .6 Capacity: Refer to the drawing schedules.
- .7 Acceptable Material: Northern Blower

Part 3 Execution

3.1 INSTALLATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 General: install level and firmly anchored to supports in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- .1 Site Tests and Inspections:
 - .1 Perform tests as directed by Consultant to ensure system is functional.
 - .2 Obtain reports within 3 days of review and submit immediately to Consultant.
- .2 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.
- .3 Manufacturer's Field Services:

- .1 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .2 Ensure manufacturer's representative is present before and during start-up and testing.
- .3 Schedule site visits:
 - .1 During start-up and commissioning of the system.

3.3 MANUFACTURER STARTUP, TRAINING, AND SERVICE

- .1 Startup
 - .1 Provide all labor and materials to perform startup.
 - .2 Startup shall be performed by a factory-trained technician from the original equipment manufacturer (OEM). Technician shall confirm that equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty. This shall be done in strict accordance with manufacturer's specifications and requirements.
 - .3 Third-party service agencies are not permitted.
 - .4 A start-up log shall be furnished by the factory approved start-up technician to document the system's start-up date and shall be signed by the owner or his authorized representative prior to commissioning the chillers.
- .2 Training
 - .1 OEM factory service technician shall provide a minimum of 4 hours training on system operation, use, and maintenance procedures.
 - .2 Training to be coordinated with other Division 23 and 25 training sessions once Division 22 and 25 system start-ups are complete to ensure operational training is real-world and actual heat demands can be placed on the system.
 - .3 Coordinate training with requirements of Section 01 00 10 - General Requirements.
- .3 OEM factory service technician shall return to site to perform an on-site operating inspection to confirm the systems operational performance after the first heating season (September to May) of operation.
 - .1 The manufacturer shall provide the owner with a report describing the condition of the equipment, current operating log, any issues found needing to be addressed, and recommended corrective actions.
 - .2 Allow for 4 hours of operator training and questions during site visit.
- .4 Provide the Owner with a quote for an optional Service Agreement which shall include:
 - .1 During the first 12 months of operation, a factory-trained technician from the original equipment manufacturer (OEM) shall perform 2 on-site operating inspections to confirm the systems operational performance. The manufacturer shall provide the owner with a report describing the condition of the equipment, current operating log, any issues found needing to be addressed, and recommended corrective actions.

3.4 SYSTEM START-UP

- .1 General: perform start-up operations in accordance with Section 01 00 10 - General Requirements and Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, supplemented as specified herein.
- .2 Check water treatment system is complete, operational and correct treatment is being applied.
- .3 Check installation, settings, operation of relief valves and safety valves.
- .4 Check installation, location, settings and operation of operating, limit and safety controls.
- .5 Check supports, seismic restraint systems.
- .6 General: perform performance verification in accordance with Section 01 00 10 - General Requirements and Section 23 08 13 - Performance Verification of HVAC Systems, supplemented as specified.
- .7 Timing: only after TAB of hydronic systems have been successfully completed.
- .8 Primary side:
 - .1 Primary side of heat exchanger:
 - .1 Measure flow rate, pressure drop and air temperature at exchanger inlet and outlet.
 - .2 Secondary side of heat exchanger:
 - .1 Measure flow rate, pressure drop and water temperature at exchanger inlet and outlet.
 - .2 Verify installation and operation of air elimination devices.
 - .3 Calculate heat transfer from primary and secondary sides.
 - .4 Verify settings, operation, safe discharge from safety valves and relief valves.
 - .5 Verify settings, operation of operating, limit and safety controls and alarms.
 - .6 Reports:
 - .1 In accordance with Section 01 00 10 - General Requirements
 - .2 Manufacturer's start-up and commissioning report

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by heat exchanger installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 79 00.13 - Demonstration and Training for Building Commissioning
- .2 Section 01 00 10 - General Requirements
- .3 Section 23 05 03 - Mechanical Startup.
- .4 Section 23 05 13 - Common Motor Requirements for HVAC Equipment
- .5 Section 23 05 48 - Vibration and Seismic Controls for HVAC
- .6 Section 23 07 16 - Thermal Insulation for Equipment
- .7 Section 23 07 19 - HVAC Piping Insulation
- .8 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems
- .9 Section 23 08 13 - Performance Verification of HVAC Systems

1.2 REFERENCE STANDARDS

- .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI):
 - .1 AHRI-550/590- 11 , Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle
 - .2 AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
- .2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 15 - Safety Code for Mechanical Refrigeration
 - .2 ASHRAE 90.1 - Energy Efficient Design of New Buildings
- .3 American Society of Mechanical Engineers International (ASME)
 - .1 ASME Code, Section VIII.
- .4 American National Standards Institute (ANSI)
 - .1 ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings.
- .5 ASTM International (ASTM):
 - .1 [ASTM C547- 19](#) , Standard Specification for Mineral Fiber Pipe Insulation
 - .2 ASTM B117 - Standard Method of Salt Spray (Fog) Testing
 - .3 ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - .4 ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products
 - .5 ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments
- .6 CSA Group (CSA):
 - .1 [CSA B52- 18](#) , Mechanical Refrigeration Code
 - .2 CSA C22.1 (latest edition), Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
- .7 Environment Canada, EC/Environmental Protection Services (EPS):

- .1 Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems, 2015
- .8 Underwriters Laboratories (UL)
 - .1 UL 1995 - Central Cooling Air Conditioners
- .9 Yukon Boiler and Pressure Vessels Act.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, product literature and data sheets for chillers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate:
 - .1 Equipment including connections, piping and fittings, valves, strainers, control assemblies and ancillaries, identifying factory and site assembled.
 - .2 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
 - .3 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
 - .4 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
 - .5 Details of vibration isolation.
 - .6 Type of refrigerant used.
 - .7 Acoustic performance data. Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for reciprocating water chillers for incorporation into manual.
- .3 Data to include:
 - .1 Description of equipment giving manufacturers name, model type and year, capacity and serial numbers.
 - .2 Submit part load performance curves.
 - .3 Details on operation, servicing and maintenance.
 - .4 Recommended spare parts list.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

1.6 WARRANTY

- .1 For Work of this Section 23 64 00 - Air Cooled Scroll Water Chillers, 12 months warranty period is extended to 60 months.
- .2 Contractor hereby warrants that Air Cooled Scroll Water Chillers will function and operate in accordance with CCDC 2 GC 24, but for 24 months.
- .3 Provide a full parts warranty for one year from start-up.

1.7 ENERGY EFFICIENCY PERFORMANCE

- .1 Packaged water chillers must meet the minimum coefficient of performance (COP) and integrated part-load value (IPLV) as specified in CSA-C743-02, Section 6, and listed in Table 9 or minimum adjusted COP and non-standard part load value (NPLV) for centrifugal equipment not designed to operate at standard rating conditions in Tables 10 to 15 of CSA-C743-02.
- .2 Packaged water chillers must carry a Standards Council of Canada verification mark indicating that the energy performance of the chiller has been verified.
- .3 The energy efficiency report (Section 5 of Canada's Energy Efficiency Act) must be submitted by the dealer to the Minister of NRCan before the chiller is imported into Canada or traded interprovincially for the first time.

Part 2 Products

2.1 AIR COOLED SCROLL WATER CHILLERS

- .1 General:
 - .1 Provide complete air cooled chiller package including: compressor(s); evaporator; condenser; condenser fan(s) and motor(s) and motor starter(s); controls; control panel; piping; wiring; refrigeration and oil charge; ready for connection to chilled water circuit; interlocks and electric power source.
 - .2 Chiller ARI 590 certified.
 - .3 Chiller factory run tested prior to shipment under simulated operating conditions.
 - .4 On dual and multiple compressor chillers provide independent dual refrigerant circuits.

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- .5 Chiller controls shall communicate with the building EMCS system via a BACnet connection.
 - .2 Casing:
 - .1 Units shall be constructed of a welded galvanized steel frame with 1.78 and 1.47 mm thick (14 and 16 ga) steel panels and access doors finished in corrosion resistant, baked on powder paint. Louvred galvanized steel panel to cover all open ends of the unit.
 - .1 The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B117.
 - .2 Mount starters and Terminal Blocks in a UL 1995 rated weatherproof panel provided with full opening access doors.
 - .1 If a circuit breaker is chosen, it should be a lockable, through-the-door type with an operating handle and clearly visible from outside of chiller indicating if power is on or off.
 - .3 Control panel doors shall have door stays.
 - .3 Compressor:
 - .1 Multiple direct driven fully hermetic scroll type compressors with R410A optimized and dedicated scroll profile.
 - .2 Direct drive motors cooled by suction gas with only three major moving parts and a completely enclosed compression chamber for increased efficiency.
 - .3 Each compressor shall have overload protection internal to the compressor.
 - .4 Each compressor shall include: suction and discharge shut-off valves, automatic reversing oil pump, oil level sight glass, oil charging valve, and cylinder unloading device.
 - .5 Each compressor will have crankcase heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
 - .4 Evaporator:
 - .1 Evaporator shall be a high efficiency, brazed plate-to-plate type heat exchanger consisting of parallel plates. Braze plates shall be stainless steel with copper braze material.
 - .2 The water side working pressure shall be rated at 1035 kPa and tested at 1.5 times maximum allowable water side working pressure.
 - .3 The refrigerant side working pressure shall be rated at 2960 kPa and tested at 1.1 maximum allowable refrigerant side working pressure.
 - .4 The evaporator shall be factory insulated with a minimum of 19mm (K=0.28) UV rated insulation.
 - .5 Evaporator heaters shall be factory installed and shall protect chiller down to -29°C.
 - .1 Contractor shall wire separate power to energize heat tape and protect evaporator while chiller is disconnected from the main power.
 - .6 Provide factory installed cleanable strainer, water drain connection, vent and fittings.
 - .7 Provide factory installed and wired leaving water temperature control and low temperature cutout sensors and proof of flow sensor.

- .8 Water connections shall be grooved pipe.
- .5 Condenser:
 - .1 Aluminum fins mechanically bonded to copper tube, pressure tested to 4480 kPa
 - .2 The condenser coils shall have an integral sub-cooling circuit and shall be designed for 4480 kPa working pressure.
- .6 Fans
 - .1 Low sound direct driven, steel or aluminum propeller type fans, statically and dynamically balanced.
 - .2 TEAO motors with permanently lubricated ball bearings and external overload protection.
- .7 Refrigerant Piping:
 - .1 All chillers shall have 1 or 2 refrigeration circuits (chiller size dependent), each with two or three (manifolded) compressors on each circuit.
 - .2 Refrigerant piping, valves, fittings and related parts to CSA B52 and including:
 - .1 Liquid line shutoff valve
 - .2 Discharge service valve
 - .3 Combination filter/dryer.
 - .4 Liquid line sight glass.
 - .5 Electronic expansion valve sized for maximum operating pressure
 - .6 Charging valve
 - .7 Liquid sight glasses, complete with moisture indicator.
 - .8 High side pressure relief device.
 - .9 Suction line insulation.
 - .3 Full operating charge of R410A refrigerant and oil to be provided with Chiller.
- .8 Chiller mounted starter
 - .1 Unit shall have a single point power connection.
 - .2 The starter shall be across-the-line configuration, factory-mounted and fully pre-wired to the compressor motor(s) and control panel.
 - .3 A control power transformer shall be factory-installed and factory-wired to provide unit control power.
 - .4 Control panel shall be dead front construction for enhanced service technician safety
 - .5 Unit wiring shall run in liquid-tight conduit.
 - .6 A molded case standard interrupting capacity circuit breaker shall be factory pre-wired with terminal block power connections and equipped with a lockable external operator handle, making it available to disconnect the chiller from main power
- .9 Controls
 - .1 Factory-mounted to the control panel door, the operator interface has an LCD touch-screen display

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- .2 Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor, evaporator, and motor information as well as associated diagnostics.
 - .3 The chiller control panel shall provide password protection of all set-points
 - .4 Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer.
 - .5 The front of the chiller control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges:
 - .1 Run time.
 - .2 Number of starts.
 - .3 Current chiller operating mode.
 - .4 Chilled water set point and set point source.
 - .5 Electrical current limit set point and set point source.
 - .6 Entering and leaving evaporator water temperatures.
 - .7 Saturated evaporator and condenser refrigerant temperatures.
 - .8 Evaporator and condenser refrigerant pressure.
 - .9 Differential oil pressure.
 - .10 Phase reversal/unbalance/single phasing and over/under voltage protection.
 - .11 Low chilled water temperature protection.
 - .12 High and low refrigerant pressure protection.
 - .13 Load limit thermostat to limit compressor loading on high return water temperature.
 - .14 Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize chiller efficiency.
 - .15 Display diagnostics.
 - .16 Compressors: Status (on/off), %RLA, anti-short cycle timer, and automatic compressor lead-lag.
 - .6 On chiller, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer.
 - .7 The chiller controller shall utilize a microprocessor that will automatically take action to prevent chiller shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.
 - .8 Provide the following safety controls with indicating lights or diagnostic readouts.
 - .1 Low chilled water temperature protection.
 - .2 High refrigerant pressure.
 - .3 Loss of chilled water flow.
 - .4 Contact for remote emergency shutdown.

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- .5 Motor current overload.
 - .6 Phase reversal/unbalance/single phasing.
 - .7 Over/under voltage.
 - .8 Failure of water temperature sensor used by controller.
 - .9 Compressor status (on or off).
 - .9 Provide the following operating controls:
 - .1 A variable method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
 - .2 Chilled water pump output relay that closes when the chiller is given a signal to start.
 - .3 Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.
 - .4 High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.
 - .5 Compressor current sensing unloader chiller that unloads compressors to help prevent current overload nuisance trip outs.
 - .6 Low ambient lockout control with adjustable setpoint.
 - .7 Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing chiller efficiency.
 - .10 Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:
 - .1 Leaving chilled water setpoint adjustment from LCD input
 - .2 Entering and leaving chilled water temperature output
 - .3 Pressure output of condenser
 - .4 Pressure output of evaporator
 - .5 Ambient temperature output
 - .6 Voltage output
 - .7 Current limit setpoint adjustment from LCD input.
 - .11 The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.
 - .12 Digital Communications to EMCS system shall consist of a BACnet MS/TP interface via a single twisted pair wiring.
 - .10 Operation:
 - .1 Chiller shall be able to start and operate in ambient conditions from -18°C to 52°C.

- .1 Wide ambient operation is accomplished with factory installed and tested protection. Field installed solution not acceptable.
- .2 Chiller shall be capable of operating with a leaving solution temperature range 4.4 to 20°C without glycol.
- .3 Chiller shall be capable of starting up with 35°C entering fluid temperature to the evaporator.
 - .1 Maximum water temperature that can be circulated through the Chiller when not operating is 52°C.
- .4 Chiller shall provide evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of chiller operation.
 - .1 Whenever this control is in effect, the controller shall indicate that the chiller is in adaptive mode.
 - .2 If the condition exists for more than 30 seconds, a limit warning alarm relay shall energize.
- .5 The Chiller shall be capable of starting in 45 seconds after a power outage.
- .11 Noise Levels:
 - .1 Noise levels from the air cooled chiller shall not exceed 65 dB, measured at a distance of 9 m from the nearest face of the unit (dB re. 20 micro pascal) and 100% loaded.
- .12 Power: 600V/3Ø/60Hz, single point power connection.
- .13 Capacity: refer to drawing schedule
- .14 Standard of Acceptance: Trane CGAM series air-cooled chiller

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Level the chiller using the base rail as a reference. The chiller must be level within 13mm over the entire length and width. Use shims as necessary to level the chiller.

3.2 INSTALLATION - AIR COOLED CHILLERS

- .1 Unit to be installed as indicated and to manufacturers recommendations, ensuring adequate clearances for servicing and maintenance.
- .2 Arrange piping for easy dismantling to permit tube cleaning.
- .3 Provide thermometers on both entering and leaving side of evaporator.
- .4 Provide drain valves and vent cocks to each header.
- .5 Ensure manufacturers field service representative approves installation and is present to supervise start up and to instruct operators.
- .6 The following shall be provided and installed as per other Divisions/Sections:
 - .1 Main fused disconnect - Division 26.

- .2 Power wiring from disconnect switch to Chiller connection - Division 26.
- .3 Power wiring and disconnect switch to evaporator heat tape - Division 26.
- .4 All wiring and conduit between control panel and remote interlocks shall be as per Division 26 and Section 25 30 02. External interlock circuits include chilled water pump starter, flow switches, temperature sensor and B.M.S interface.
- .5 Wiring for oil pump between pump starter and pump shall be provided as per Division 26 and Section 25 30 02.
- .6 Flow switches on chilled water circuits shall be provided as per Section 25 30 02.
- .7 Vibration isolation shall be provided as per Section 23 05 48.
- .8 All unit components, which may cause condensation, shall be insulated on site as per Section 23 07 16 unless unit is factory insulated.

3.3 MANUFACTURER STARTUP, TRAINING, AND SERVICE

- .1 Startup
 - .1 Provide all labor and materials to perform startup.
 - .2 Startup shall be performed by a factory-trained technician from the original equipment manufacturer (OEM). Technician shall confirm that equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty. This shall be done in strict accordance with manufacturer's specifications and requirements.
 - .3 Third-party service agencies are not permitted.
 - .4 A start-up log shall be furnished by the factory approved start-up technician to document the chiller's start-up date and shall be signed by the owner or his authorized representative prior to commissioning the chillers.
- .2 Training
 - .1 OEM factory service technician shall provide a minimum of 4 hours training on chiller operation, use, and maintenance procedures.
 - .2 Training to be coordinated with other Division 23 and 25 training sessions once Division 22 and 25 system start-ups are complete to ensure operational training is real-world and actual cooling demands can be placed on the system.
 - .3 Coordinate training with requirements of Section 01 00 10 - General Requirements and Section 01 79 00.13 - Demonstration and Training for Building Commissioning.
- .3 Chiller manufacturers shall maintain service capabilities no more than 2.5 hr flight from the jobsite. Provide local service agent with direct access to factory support on equipment.
- .4 OEM factory service technician shall return to site to complete seasonal shutdown for the first year of operation.
 - .1 Include seasonal shut-down in Construction Progress Schedule
 - .1 Coordinate specific dates with owner's availability and seasonal shut down schedule.
 - .2 Allow for operator training during/after seasonal shut-down.
- .5 Provide the Owner with a quote for an optional Service Agreement which shall include:

- .1 During the first 12 months of operation, a factory-trained technician from the original equipment manufacturer (OEM) shall perform quarterly on-site operating inspections to confirm the chiller's operational performance. The manufacturer shall provide the owner with a report describing the condition of the equipment, current operating log, any issues found needing to be addressed, and recommended corrective actions.

3.4 SYSTEM START-UP

- .1 General: perform start-up operations in accordance with Section 01 00 10 - General Requirements and Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, supplemented as specified herein.
- .2 Check water treatment system is complete, operational and correct treatment is being applied.
- .3 Check installation, settings, operation of relief valves and safety valves.
- .4 Check installation, location, settings and operation of operating, limit and safety controls.
- .5 Check supports, seismic restraint systems.
- .6 General: perform performance verification in accordance with Section 01 00 10 - General Requirements and Section 23 08 13 - Performance Verification of HVAC Systems, supplemented as specified.
- .7 Timing: only after TAB of hydronic systems have been successfully completed.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by chiller installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems
- .3 Section 23 05 00 - Common Work Results for HVAC
- .4 Section 23 05 03 - Mechanical Startup.
- .5 Section 23 05 13 - Common Motor Requirements for HVAC Equipment
- .6 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .7 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC
- .8 Section 23 08 13 - Performance Verification of HVAC Systems
- .9 Section 23 82 16 - Air Coils
- .10 Section 26 05 00 - Common Work Results for Electrical

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 84-2013, Method of Testing Air-to-Air Heat/Energy Exchangers (ANSI approved).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data: Submit in accordance with Section 01 00 10 - General Requirements
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for energy recovery equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Indicate following:
 - .1 Fan design and construction.
 - .2 Fan curves showing point of operation.
 - .3 Motor design and construction including electrical ratings, approvals, efficiency.
 - .4 Filters.
 - .5 Dampers.
 - .6 Energy recovery equipment.
 - .1 Detailed verification of energy recovery performance showing variation of efficiency over entire damper cycle. Statement of energy efficiency must include test results utilizing consistent temperature condition consistent with design values indicated and must be stamped by a professional engineer licensed in Canada.
 - .7 Unit wall, floor and casing details of construction.
 - .8 Acoustic data including:

- .1 Fan inlet and discharge SPL.
- .9 Performance data including selection points and acoustic data.
- .10 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit maintenance materials in accordance with Section 01 00 10 - General Requirements
- .2 Extra Materials:
 - .1 Spare filters: in addition to filters installed immediately prior to acceptance by Consultant, supply 1 complete set of filters for each filter unit or filter bank.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect energy recovery equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work
- .5 Packaging Waste Management: remove for reuse by manufacturer of padding, as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

1.6 WARRANTY

- .1 For Work of this Section 23 72 00 - Air-to-Air Energy Recovery Equipment, 12 months warranty period is extended to 60 months.

Part 2 Products

2.1 GENERAL

- .1 Comply with ASHRAE 84.

2.2 ENERGY RECOVERY VENTILATOR - LARGE

- .1 Indoor packaged energy recovery unit, with single damper configuration. Utilize a Reverse Flow regeneration type fresh air/exhaust air recovery methodology.
- .2 Capacity: as indicated in drawing schedules
- .3 Energy transfer cassettes shall have a 10-year warranty.
- .4 Housing:
 - .1 Double-walled, insulated, air pressure tight casing assemblies. No through metal shall be allowed. Where dissimilar metals are used, they shall be dialectically isolated from one another to prevent galvanic action. All seals and gaskets shall be changeable and constructed of EPDM rubber with working temperature range of -40°C to 54°C.
 - .2 Assembled panels shall be a minimum of 57 mm thick and shall be fabricated with a minimum 16-gauge solid exterior sheet and 16-gauge solid inside panel. Inner panels shall be sealed to each other using adhesive sealant and mechanically fastened.
 - .3 Interior panel insulation shall be 50 mm thick, fiberglass. Panel shall a minimum RSI 2.5, ULC fire rating, flame spread 10-20, fuel contributed 10-15, smoke developed 0-20.
 - .4 Acoustical housing sections shall be similar except 20-gauge perforated inner sheet, with 3/4 mil polyethylene covering between the insulation and the perforated coversheet.
 - .5 The structure shall be self-supporting. Maximum allowable panel deflection is 1/200th of the panel span at full rated unit static pressure.
 - .6 Roof panels will be of the same construction as the wall.
- .5 Base:
 - .1 Unit casing shall be built up on a structural steel channel base suitably sized to prevent deflection during rigging. The entire unit floor will be constructed of galvanized steel. All seams in the floor shall be tack welded and sealed.
 - .2 The entire depth of the channel shall be insulated with RSI 3.35 fiberglass insulation. The sides of the floor pan shall be insulated to prevent condensation at the channel base.
 - .3 Unit drain pans are required in the heat transfer sections. They shall be continuously welded, watertight 304 stainless steel with 32 mm drain connections. Each pan will pitch for positive condensate drainage.
 - .4 All carbon steel surfaces shall be coated with Heresite air-dry phenolic. Steel floor surfaces shall be top-coated with Heresite air-dry phenolic.
 - .5 The underside of the base will be covered with a 20-gauge galvanized coversheet.
 - .6 Lifting lugs will be bolted on (removable).
- .6 Damper Section:
 - .1 The damper housing wall panels and base frame are constructed similar to the heat recovery section housing.

-
- .2 The reversing damper blade is constructed with an internal structural steel frame and skimmed both sides with 16ga galvalume. The internal cavity is fully insulated with rigid fiberglass.
 - .3 The damper drive shaft is solid turned, ground and polished round shaft stock, mechanically fastened into the internal damper frame. The drive shaft extends up through the roof of the damper housing and connects to the drive mechanism frame using tandem flange mounted bearings. Damper drive shafts shall be a minimum size of 25 mm OD. the shaft penetration shall be furnished with a flexible rubber seal.
 - .4 EPDM Rubber will be used for seals. Seals are to be attached without the use of adhesives for ease of maintenance and replacement.
 - .7 Access Doors:
 - .1 Access doors are required for all sections. They are to be double wall construction, fabricated and insulated with the same gauge and quality of materials as the main housing. Structural steel shall be provided within the door and frame. All hinges and latches shall be mounted to structural steel. Mounting to sheet metal only is not acceptable.
 - .2 Each door and frame shall be fabricated with integral flanges, which supports neoprene gaskets which mates to the doorframe. All gaskets are to be mechanically fastened to mounting flange.
 - .3 All access doors are to be hinged using a minimum of two flush offset hinges with nylon bearings.
 - .4 All access doors shall be provided with a minimum of two latches, provided with both interior and exterior turn handles.
 - .8 Heat Transfer Cassettes:
 - .1 The Reverse Flow energy recovery system shall utilize pure aluminum plates of 1100 alloy. The structural frames are constructed of 16-gauge 304 stainless steel.
 - .2 The energy transfer cassettes shall be modular and utilize aluminum plates with a minimum thickness of 0.7 mm and a plate mass of 48 kg for each 238 l/s of air. With a sensible energy recovery effective rate of 90% winter 80% summer +-5% and latent recovery of up to 70% during cold winter conditions. System will not require freeze protection to -40°C under standard application.
 - .3 Energy transfer cassettes shall be easily accessible by individual module, removable and cleanable with a pressure washer.
 - .4 Performance to be based on 70 second damper cycle (70 seconds fixed in position). Supply temperature must be sustained within 1.6 degree C differential during the entire 70 second damper cycle. Factory test verifying performance levels through damper cycle must be documented for design conditions indicated and signed off by professional engineer licensed to practice in Canada submitted during the shop drawing approval.
 - .9 Drain Pans:
 - .1 Stainless reverse sloped drain pan will be provided under each cassette bank to facilitate and control condensate removal.
 - .10 Filters:
 - .1 Pre-filter shall be MERV 8.

- .2 Final filter shall be MERV 13.
- .11 Cleaning:
 - .1 Unit shall be of a self-cleaning design. Cassette will have the capability to be power washed in the field.
- .12 Electrical Work:
 - .1 Electrical work shall be per CEC. Electrical systems shall be CSA approved.
 - .2 Unit manufacturer shall completely wire all components to single point power connections.
 - .3 Units shipped in sections shall have pre-tagged wiring for quick connection of electrical circuits.
 - .4 Unit shall have internal LED marine lights for servicing.
- .13 Controls:
 - .1 An integral control panel shall be mounted on the unit.
 - .2 Controls to include the following components:
 - .1 Damper control timer with build-in economizer (built in clock with 6 points of input, 4 output)
 - .2 Fast acting electronic actuators
 - .3 On/off switch and building power connection block.
 - .3 Precision electric damper actuator for main reversing damper, continuous duty rating, adjustable limit switch positioning.
 - .4 Controls system complete with required integral power supplies and electronic circuit protection, electrical enclosure cooling fan, completely factory wired.
 - .5 Provide BACnet Interface Devices so that the units are presented as a series of AV and BV BACnet objects.
 - .6 The following controls contacts are to be provided for interface to the BAS (via ERV LCP):
 - .1 Economizer mode by reducing the heat exchange for free cooling.
 - .2 Variable air volume mode by varying the air flows using VFDs for the fans.
 - .3 Damper stop.
 - .4 Status.
 - .5 Common alarm.
- .14 Standard of Acceptance: Bousquet Technologies Superblock
 - .1 Acceptable Alternates: Solution Air RegenCore

2.3 ENERGY RECOVERY VENTILATOR - SMALL

- .1 Indoor packaged energy recovery unit, with single damper configuration. Utilize a Reverse Flow regeneration type fresh air/exhaust air recovery methodology.
- .2 Capacity: as indicated in drawing schedules
- .3 Energy transfer cassettes shall have a 10-year warranty.
- .4 Housing:

- .1 Double-walled, insulated, air pressure tight casing assemblies. No through metal shall be allowed. Where dissimilar metals are used, they shall be dialectically isolated from one another to prevent galvanic action. All seals and gaskets shall be changeable and constructed of EPDM rubber with working temperature range of -40°C to 54°C.
 - .2 Assembled panels shall be a minimum of 57 mm thick and shall be fabricated with a minimum 16-gauge solid exterior sheet and 16-gauge solid inside panel. Inner panels shall be sealed to each other using adhesive sealant and mechanically fastened.
 - .3 Interior panel insulation shall be 50 mm thick, fiberglass. Panel shall a minimum RSI 2.5, ULC fire rating, flame spread 10-20, fuel contributed 10-15, smoke developed 0-20.
 - .4 Acoustical housing sections shall be similar except 20-gauge perforated inner sheet, with 3/4 mil polyethylene covering between the insulation and the perforated coversheet.
 - .5 The structure shall be self-supporting. Maximum allowable panel deflection is 1/200th of the panel span at full rated unit static pressure.
 - .6 Roof panels will be of the same construction as the wall.
- .5 Base:
- .1 Unit casing shall be built up on a structural steel channel base suitably sized to prevent deflection during rigging. The entire unit floor will be constructed of galvaneal steel. All seams in the floor shall be tack welded and sealed.
 - .2 The entire depth of the channel shall be insulated with RSI 3.35 fiberglass insulation. The sides of the floor pan shall be insulated to prevent condensation at the channel base.
 - .3 Unit drain pans are required in the heat transfer sections. They shall be continuously welded, watertight 304 stainless steel with 32 mm drain connections. Each pan will pitch for positive condensate drainage.
 - .4 All carbon steel surfaces shall be coated with Heresite air-dry phenolic. Steel floor surfaces shall be top-coated with Heresite air-dry phenolic.
 - .5 The underside of the base will be covered with a 20-gauge galvanized coversheet.
 - .6 Lifting lugs will be bolted on (removable).
- .6 Damper Section:
- .1 The damper housing wall panels and base frame are constructed similar to the heat recovery section housing.
 - .2 The reversing damper blade is constructed with an internal structural steel frame and skimmed both sides with 16ga galvaneal. The internal cavity is fully insulated with rigid fiberglass.
 - .3 The damper drive shaft is solid turned, ground and polished round shaft stock, mechanically fastened into the internal damper frame. The drive shaft extends up through the roof of the damper housing and connects to the drive mechanism frame using tandem flange mounted bearings. Damper drive shafts shall be a minimum size of 25 mm OD. the shaft penetration shall be furnished with a flexible rubber seal.

- .4 EPDM Rubber will be used for seals. Seals are to be attached without the use of adhesives for ease of maintenance and replacement.
- .7 Access Doors:
 - .1 Access doors are required for all sections. They are to be double wall construction, fabricated and insulated with the same gauge and quality of materials as the main housing. Structural steel shall be provided within the door and frame. All hinges and latches shall be mounted to structural steel. Mounting to sheet metal only is not acceptable.
 - .2 Each door and frame shall be fabricated with integral flanges, which supports neoprene gaskets which mates to the doorframe. All gaskets are to be mechanically fastened to mounting flange.
 - .3 All access doors are to be hinged using a minimum of two flush offset hinges with nylon bearings.
 - .4 All access doors shall be provided with a minimum of two latches, provided with both interior and exterior turn handles.
- .8 Heat Transfer Cassettes:
 - .1 The Reverse Flow energy recovery system shall utilize pure aluminum plates of 1100 alloy. The structural frames are constructed of 16-gauge 304 stainless steel.
 - .2 The energy transfer cassettes shall be modular and utilize aluminum plates with a minimum thickness of 0.7 mm and a plate mass of 48 kg for each 238 l/s of air. With a sensible energy recovery effective rate of 90% winter 80% summer +-5% and latent recovery of up to 70% during cold winter conditions. System will not require freeze protection to -40°C under standard application.
 - .3 Energy transfer cassettes shall be easily accessible by individual module, removable and cleanable with a pressure washer.
 - .4 Performance to be based on 70 second damper cycle (70 seconds fixed in position). Supply temperature must be sustained within 1.6 degree C differential during the entire 70 second damper cycle. Factory test verifying performance levels through damper cycle must be documented for design conditions indicated and signed off by professional engineer licensed to practice in Canada submitted during the shop drawing approval.
- .9 Drain Pans:
 - .1 Stainless reverse sloped drain pan will be provided under each cassette bank to facilitate and control condensate removal.
- .10 Filters:
 - .1 Unit filter shall be MERV 8.
- .11 Cleaning:
 - .1 Unit shall be of a self-cleaning design. Cassette will have the capability to be power washed in the field.
- .12 Electrical Work:
 - .1 Electrical work shall be per CEC. Electrical systems shall be CSA approved.
 - .2 Unit manufacturer shall completely wire all components to single point power connections.

- .3 Units shipped in sections shall have pre-tagged wiring for quick connection of electrical circuits.
- .13 Controls:
 - .1 An integral control panel shall be mounted on the unit.
 - .2 Controls to include the following components:
 - .1 Damper control timer with build-in economizer (built in clock with 6 points of input, 4 output)
 - .2 Fast acting electronic actuators
 - .3 On/off switch and building power connection block.
 - .3 Precision electric damper actuator for main reversing damper, continuous duty rating, adjustable limit switch positioning.
 - .4 Controls system complete with required integral power supplies and electronic circuit protection, electrical enclosure cooling fan, completely factory wired.
 - .5 Provide BACnet Interface Devices so that the units are presented as a series of AV and BV BACnet objects.
 - .6 The following controls contacts are to be provided for interface to the BAS (via ERV LCP):
 - .1 Economizer mode by reducing the heat exchange for free cooling.
 - .2 Damper stop.
 - .3 Status.
 - .4 Common alarm.
- .14 Standard of Acceptance: Solution Air PRCLC series
 - .1 Acceptable Alternates: Bousquet Technologies Superblock

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturers recommendations level and secure on concrete housekeeping pad.
- .2 Unit to be secured thru concrete pad to structure as per SRS details.
- .3 Provide for sheaves as required for final air balancing where belt drive fans/motors are provided.
- .4 Ensure adequate clearance for servicing and maintenance.
- .5 Unit shall be stored and handled per unit manufacturer's recommendations.
- .6 Support independently of adjacent ductwork with flexible connections.
- .7 Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to filters, dampers, and internal control components.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 79 00.13 - Demonstration and Training for Building Commissioning
- .2 Section 01 00 10 - General Requirements
- .3 Section 23 05 03 - Mechanical Startup.
- .4 Section 23 05 13 - Common Motor Requirements for HVAC Equipment
- .5 Section 23 05 48 - Vibration and Seismic Controls for HVAC
- .6 Section 23 07 16 - Thermal Insulation for Equipment
- .7 Section 23 07 19 - HVAC Piping Insulation
- .8 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems
- .9 Section 23 08 13 - Performance Verification of HVAC Systems

1.2 ABBREVIATIONS AND ACRONYMS

- .1 Abbreviations and acronyms used in this Section are defined as:
 - .1 COP: coefficient of performance
 - .2 DBT: dry bulb temperature
 - .3 WBT: wet bulb temperature
 - .4 EDBT: entering dry bulb temperature
 - .5 EWBT: entering wet bulb temperature
 - .6 LWT: leaving water temperature
 - .7 EWT: entering water temperature
 - .8 DX: direct exchange
 - .9 DWDI: double width, double inlet
 - .10 DHW: domestic hot water
 - .11 EER: energy efficiency ratio
 - .12 HSPF: heating seasonal performance factor
 - .13 SEER: seasonal energy efficiency ratio
 - .14 WOG: water, oil, gas

1.3 REFERENCE STANDARDS

- .1 Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - .1 ANSI/AHRI 340/360- 2007, Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
- .2 American Society of Mechanical Engineers (ASME):
 - .1 ASME BPVC-2023, Boiler and Pressure Vessel Code
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - .1 ANSI/ASHRAE Standard 15-2010, Safety Standard for Refrigeration Systems.
 - .2 ASHRAE 90.1 - Energy Efficient Design of New Buildings

- .4 Air-Conditioning and Refrigeration Institute (ARI)
 - .1 ARI 320-1998, Standard for Water-Source Heat Pumps.
- .5 CSA Group (CSA):
 - .1 CSA B52- 18, Mechanical Refrigeration Code
 - .2 CSA C22.1, Canadian Electrical Code, Part I (latest edition), Safety Standard for Electrical Installations
 - .3 CAN/CSA-C656-05(R2010), Performance Standard for Split-System and Single Package Central Air Conditioners and Heat Pumps.
 - .4 CAN/CSA-C746-06, Performance Standard for Rating Large and Single Packaged Vertical Air Conditioners and Heat Pumps
 - .5 CAN/CSA-C13256-2-01, Water-Source Heat Pumps - Testing and Rating for Performance - Part 2: Water-to-Water and Brine-to-Water Heat Pumps (Adopted ISO 13256-2:1998, first edition, 1998-08-15, with Canadian Deviations)
- .6 Environment Canada, (EC) / Environmental Protection Services (EPS)
 - .1 EPS 1/RA/2, Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems, 2015

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, product literature and data sheets for chillers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Certificates: AHRI certificate verifying performance ratings.
- .3 Shop Drawings:
 - .1 Indicate:
 - .1 Equipment including connections, piping and fittings, valves, strainers, control assemblies and ancillaries, identifying factory and site assembled.
 - .2 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
 - .3 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
 - .4 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
 - .5 Details of vibration isolation.
 - .6 Type of refrigerant used.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: Include the following in the operation and maintenance manual:
 - .1 Manufacturer's maintenance and operating instructions.
 - .2 Recommended cleaning materials and methods.
 - .3 Wiring diagrams showing electrical connections.
 - .4 Parts catalogue showing a complete list of repair and replacement parts, with cuts and identifying numbers.
 - .5 List of special tools required for adjusting, repairing, or replacing equipment.

1.6 WARRANTY

- .1 For Work of this Section, provide an extended 5 year warranty period from time of start-up unless noted otherwise.
- .2 Compressor parts shall have a 5 year warranty from time of start-up.

Part 2 Products

2.1 DESCRIPTION

- .1 Heat pumps: to EPS 1/RA/2, CSA approved and with ARI or CSA certification seal

2.2 DRAIN PANS

- .1 Design and construct condensate drain pans under cold components so that no water can accumulate and install to allow for easy cleaning.

2.3 WATER TO WATER UNITARY HEAT PUMP

- .1 General:
 - .1 Horizontal type water to water heat pump, consisting of factory-assembled package containing water-to-refrigerant heat exchanger, compressor, refrigerant circuit (expansion valve, 4-way reversing valve), and refrigerant to water heat exchanger.
 - .2 Units shall be factory assembled, tested, and rated.
 - .3 Units shall be designed, rated, and certified in accordance with ISO-AHRI 13256-2.
 - .4 Service and caution labels shall be placed on the unit in their appropriate locations.
- .2 Performance: as indicated.
 - .1 Certified in accordance with CAN/CSA-C13256
 - .2 Ratings in accordance with CAN/CSA-C13256
- .3 Cabinet
 - .1 Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Access to the refrigerant and controls shall be provided through the front and side, access panels.

- .2 All panels shall be insulated with ½-inch thick dual density bonded glass fiber. The insulation shall meet the erosion requirements of UL 181. It shall have a flame spread of less than 25 and a smoke developed classification of less than 50 per ASTM E-84 and UL 723.
- .4 Refrigerant circuit
 - .1 General
 - .1 Refrigerant circuit to include a reversing valve, thermal expansion valve, two water-to-refrigerant heat exchanger (source and load), and a compressor selected for the optimal efficiency of each circuit.
 - .2 10 and 20 ton units incorporate a dual circuit refrigeration design, duplicating the major components listed above.
 - .2 Sealed Refrigerant Circuit: Charge with R-410A refrigerant.
 - .3 Service pressure ports shall be factory supplied on the high and low pressure sides for easy refrigerant pressure or temperature testing.
 - .4 Expansion Valve
 - .1 Refrigerant flow metering to be via a thermal expansion valve (TXV) capable of precisely meters refrigerant flow through the circuitry to achieve desired heating or cooling.
 - .2 The TXV to allow the unit to operate with an entering fluid temperature from 25° F to 120° F on the source-side.
 - .5 Filter Drier: provide a bi-directional filter drier to dehydrate and clean the refrigeration system, adding to the life of the equipment.
 - .6 Reversing Valve:
 - .1 Provide a system reversing valve (4-way valve) to with unit. This valve is piped to be energized in the cooling mode to allow the system to provided heat if valve failure were to occur. Once the valve is energized for cooling, it will remain energized until the control system is turned to the OFF position, or a heating cycle is initiated.
 - .2 The valve shall be a pilot operating, sliding piston type with a replaceable, encapsulated magnetic coil
- .5 Compressor
 - .1 High efficiency scroll compressor with internal thermal overload protection shall be provided.
 - .2 Protection against excessive discharge pressure shall be provided by means of a high-pressure switch. A loss of charge shall be detected by a low-pressure safety.
 - .3 Vibration isolation shall be provided through rubber mounting devices located underneath the compressor.
- .6 Water to refrigerant heat exchanger
 - .1 The water-to-refrigerant heat exchangers shall be of a high quality, co-axial coil (seamless tube-within-a-tube construction) for maximum heat transfer.
 - .1 The inner-water tube shall be deeply fluted to enhance heat transfer and minimize fouling and scaling.

- .1 The brown-out protection function shall measure the input voltage to the controller and halt the compressor operation. Once a brown-out situation has occurred, the anti-short cycle timer will become energized. The general fault contact will not be affected by this condition. The voltage will continue to be monitored until the voltage increases. The compressors will be enabled at this time if all start-up time delays have expired, and all safeties have been satisfied.
 - .9 Low pressure time delay
 - .10 Low pressure switch: shall be provided to protect the compressor against operation at refrigerant system pressure below 40 psig (loss of charge).
 - .11 High pressure switch: shall be provided to protect the compressor against operation at refrigerant system pressure exceeding 650 psig.
 - .12 Compressor delay on start
 - .13 Reversing valve coil
 - .14 Freeze protection shall be provided to prevent the unit from operating at low water temperatures.
 - .15 Discharge Line Thermostat shall be provided to protect the compressor against a high discharge temperatures in case of loss of charge or other conditions which could drive the discharge temperature higher.
- .9 Standard of acceptance: Trane Axiom EXW water to water series heat pump

Part 3 Execution

3.1 INSTALLATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 General: install level and firmly anchored to supports in accordance with manufacturer's recommendations.
- .3 Extend and terminate condensate piping over floor drain.
- .4 Make piping connections as indicated on Drawings.
- .5 Verify nothing is obstructing ready access to components or preventing removal of components for servicing.

3.2 DRAIN PANS

- .1 Install so no water can accumulate. Arrange to allow easy access for cleaning.
- .2 Include internal or external trap for proper draining.

3.3 SYSTEM START-UP

- .1 General: perform start-up operations in accordance with Section 01 00 10 - General Requirements and Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, supplemented as specified herein.
- .2 Check water treatment system is complete, operational and correct treatment is being applied.

- .3 Check installation, settings, operation of relief valves and safety valves.
- .4 Check installation, location, settings and operation of operating, limit and safety controls.
- .5 Check supports, seismic restraint systems.
- .6 General: perform performance verification in accordance with Section 01 00 10 - General Requirements and Section 23 08 13 - Performance Verification of HVAC Systems, supplemented as specified.
- .7 Timing: only after TAB of hydronic systems have been successfully completed.
- .8 Test units in full waster heat recovery conditions. Confirm sufficient flow in the heating and chilled water loops to prevent any pressure alarms.
- .9 Cold water side
 - .1 Measure flow rate, pressure drop and water temperature at heat pump inlet and outlet.
 - .2 Verify installation and operation of air elimination devices.
- .10 Hot water side
 - .1 Measure flow rate, pressure drop and water temperature at heat pump inlet and outlet.
 - .2 Verify installation and operation of air elimination devices.

3.4 TRAINING

- .1 In accordance with Section 01 00 10 - General Requirements and Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel, supplemented as specified.
- .2 Provide instruction on equipment and systems operation and maintenance described in this section with the following minimum durations:
 - .1 Waste heat recovery heat pump: 1 hour

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by heat pump installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Coils
 - .2 Performance data including selection points.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air coils from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of padding, pallets, crates, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 COILS

- .1 Tubes: copper, all joints brazed.
- .2 Fins: aluminum, minimum 0.15mm, mechanically expanded to provide continuous primary to secondary compression bond over entire finned length.
- .3 Frame: channel frame on 16ga galvanized steel, centre and end supports.
- .4 Pressure rating: hydrostatically tested at 2758 kPa and 104°C.
- .5 Pipe connections to be on the same end, and to be threaded.
- .6 Drain pans: where indicated.
- .7 Temperature: as per drawing schedule
- .8 Fluid: as per drawing schedule
- .9 Schedule: see drawings
- .10 Acceptable material: Engineered Air, Trane, Heat Craft, Greenheck

Part 3 Execution

3.1 INSTALLATION

- .1 Install thermostats in locations indicated.
- .2 Install as per manufacturer's instructions.
- .3 Ensure adequate clearance for serving and maintenance.
- .4 Unit shall be stored and handled per unit manufacturer's recommendations.
- .5 Provide access doors upstream and downstream of coils.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements

3.3 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by residential convectors installation.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 01 31 - Air Duct Cleaning for HVAC Systems
- .3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .4 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .5 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Section 23 08 13 - Performance Verification of HVAC Systems
- .7 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.
- .8 Section 23 31 14 - Metal Ducts - Low Pressure to 500 Pa
- .9 Section 23 33 14 - Dampers - Balancing
- .10 Section 23 33 00 - Air Duct Accessories

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
 - .1 ANSI/AMCA Standard 99-2010, Standards Handbook.
 - .2 ANSI/ASHRAE 51-07 (ANSI/AMCA 210-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .3 ANSI/AMCA Standard 300-2008, Reverberant Room Method for Sound Testing of Fans.
 - .4 ANSI/AMCA Standard 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 ASTM International (ASTM)
 - .1 ASTM E84-11a, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .2 ASTM C916-1985 (R2007), Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C1071-05e1, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-2021, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-2021, Standard for the Installation of Warm Air Heating and Air Conditioning Systems (ANSI).
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements

- .2 Product Data:
 - .1 Submit manufacturer's instructions, product literature and data sheets for fan coil units and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 00 10 - General Requirements
 - .2 Indicate the following:
 - .1 Capacity, flow, and pressure drop for air and hydronic components
 - .2 Fan performance curves showing point of operation, kW and efficiency.
 - .3 Minimum performance achievable with variable speed controllers.
 - .4 Noise rating
 - .1 Include discharge and radiated sound power level schedules with shop drawings, for each of second through sixth octave bands and inlet pressures of 250 Pa to 1000 Pa.
 - .5 Thermostat, transformer, controls where integral.
 - .6 kW rating, voltage, phase.
 - .7 Cabinet construction and method of installation (hanging)
 - .8 Filters, fan accessibility.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect fan coil units from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 MANUFACTURED UNITS

- .1 Terminal units of the same type to be product of one manufacturer.

2.2 FAN COIL UNIT - WITH DEDICATED OUTSIDE AIR INLET

- .1 Casing:
 - .1 The unit casing shall be constructed of a minimum 20 gauge, 0.032 inch galvanized steel to ASHRAE 130. The unit shall be supplied with a bottom access door, secured to the casing with snap latches.

- .2 Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
- .3 The insulation shall 1 inch thick, and be secured with adhesive. Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.
- .2 Outside air inlet:
 - .1 Pressure independent, reset to air flow between minimum and maximum air volume as required. At inlet velocity of 10 m/s, differential static pressure for unit with attenuator section not to exceed 25 Pa.
 - .2 Damper: Blade constructed of two layers of heavy gauge galvanized sheet metal with peripheral gasket of polyurethane foam. Air leakage not to exceed 2% of nominal rating at 750 Pa.
 - .3 Air velocity measurements from multi-point flow sensor as standard to manufacturer.
- .3 Blower: shall be a dynamically balanced, forward curved, double width/double inlet (DWDI) centrifugal type, constructed of zinc coated galvanized steel for corrosion resistance.
- .4 Motor:
 - .1 The unit shall be supplied with an electronically commutated motor (ECM), complete with a single phase integrated controller/inverter that operates the wound stator and senses motor position to electronically commutate the stator.
 - .2 The motor rotor shall be permanent magnet type with near zero rotor losses.
 - .3 The motor shall be permanently lubricated with ball bearings, maintaining a minimum of 70% efficiency over its entire operating range.
 - .4 The motor shall be supplied complete with a manual fan speed controller for field adjustment of fan air flow set-point.
 - .5 The speed controller shall accept as standard a 0-10VDC, or 4-20mA signal for remote fan adjustment from a building automation system.
 - .6 The ECM shall be furnished with factory programming:
 - .1 Pressure Independent Flow Program
 - .1 A pressure independent flow program shall be provided to allow the ECM to compensate for fluctuations in external static pressure, providing constant airflow.
 - .2 The air volume flow rate shall be maintained to within five percent of desired flow in a system with up to 0.50 inches water gauge of external static pressure.
- .5 Unit shall have a hot water heating coil and a chilled water cooling coil on its supply air discharge.
 - .1 Coil casing shall be constructed from a minimum 22 gauge, 0.032 inch galvanized steel, factory-installed on the terminal discharge with slip-and drive attachment for downstream ductwork.
 - .2 The water coil fins shall be 0.0045 inch aluminum fins, mechanically-bonded to seamless 0.50 by 0.016 inch copper tubes. Fins shall be formed in a high heat transfer sine wave configuration.

- .3 Standard coil shall be constructed with 10 fins-per-inch fin spacing. High capacity coil shall be constructed with 12 fins-per-inch fin spacing and larger casing to increase capacity.
- .4 The water coil shall be certified in accordance with AHRI 410 and units shall bear an AHRI 410 label.
- .6 Condensate drain pan:
 - .1 Unit shall be supplied with a drain pan that extends under the entire coil section and extends a minimum of 300mm beyond the coils on the piping connection side.
 - .2 Drain pans shall be of one-piece construction single wall galvanized steel and be positively sloped for condensate removal.
 - .3 Drain pans shall be externally insulated with fire retardant foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E84 and UL 723 and an Antimicrobial Performance Rating of zero with no observed growth per UL 181.
- .7 Unit shall have a MERV8 filter on its return connection.
- .8 Controls
 - .1 Controls to be factory mounted with wiring diagram indicating factory and field wiring. Lines to be colour coded
 - .2 Signals between temperature sensing device, coil valve actuators, velocity controller, velocity sensor and damper actuator to be through digital controller. Unit shall integrate to building BMS.
 - .3 Electronic control package to be factory calibrated and set at factory. Features to accommodate field calibration and readjustment of air volume settings.
 - .4 Factory installed 20 VA transformer, 115 V to 24 V. Power consumption of terminal not to exceed 15 VA.
- .9 Acoustics:
 - .1 The manufacturer shall supply sound attenuators to meet scheduled acoustical performance requirements. The attenuators shall be a three foot integral discharge attenuator.
- .10 Standard of Acceptance: Price FCGH series with OA module.
 - .1 Acceptable alternate: Nailor

2.3 FAN COIL UNIT

- .1 Casing:
 - .1 The unit casing shall be constructed of a minimum 20 gauge, 0.032 inch galvanized steel to ASHRAE 130. The unit shall be supplied with a bottom access door, secured to the casing with snap latches.
 - .2 Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
 - .3 The insulation shall 1/2 inch thick and be secured with adhesive. Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.

-
- .2 Blower: shall be a dynamically balanced, forward curved, double width/double inlet (DWDI) centrifugal type, constructed of zinc coated galvanized steel for corrosion resistance.
- .3 Motor:
- .1 The unit shall be supplied with an electronically commutated motor (ECM), complete with a single phase integrated controller/inverter that operates the wound stator and senses motor position to electronically commutate the stator.
- .2 The motor rotor shall be permanent magnet type with near zero rotor losses.
- .3 The motor shall be permanently lubricated with ball bearings, maintaining a minimum of 70% efficiency over its entire operating range.
- .4 The motor shall be supplied complete with a manual fan speed controller for field adjustment of fan air flow set-point.
- .5 The speed controller shall accept as standard a 0-10VDC, or 4-20mA signal for remote fan adjustment from a building automation system.
- .6 The ECM shall be furnished with factory programming:
- .1 Pressure Independent Flow Program
- .1 A pressure independent flow program shall be provided to allow the ECM to compensate for fluctuations in external static pressure, providing constant airflow.
- .2 The air volume flow rate shall be maintained to within five percent of desired flow in a system with up to 0.50 inches water gauge of external static pressure.
- .4 Unit shall have a hot water heating coil and chilled water cooling coil on its supply air discharge.
- .1 Coil casing shall be constructed from a minimum 22 gauge, 0.032 inch galvanized steel, factory-installed on the terminal discharge with slip-and drive attachment for downstream ductwork.
- .2 The water coil fins shall be 0.0045 inch aluminum fins, mechanically-bonded to seamless 0.50 by 0.016 inch copper tubes. Fins shall be formed in a high heat transfer sine wave configuration.
- .3 Standard coil shall be constructed with 10 fins-per-inch fin spacing. High capacity coil shall be constructed with 12 fins-per-inch fin spacing and larger casing to increase capacity.
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- .3 Drain pans shall be externally insulated with fire retardant foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E84 and UL 723 and an Antimicrobial Performance Rating of zero with no observed growth per UL 181.

- .6 Unit shall have a MERV8 filter on its return connection.
- .7 Controls
 - .1 Controls to be factory mounted with wiring diagram indicating factory and field wiring. Lines to be colour coded
 - .2 Signals between temperature sensing device and coil valve actuators to be through digital controller. Unit shall integrate to building BMS.
 - .3 Electronic control package to be factory calibrated and set at factory. Features to accommodate field calibration and readjustment of air volume settings.
 - .4 Factory installed 20 VA transformer, 115 V to 24 V. Power consumption of terminal not to exceed 15 VA.
- .8 Acoustics:
 - .1 The manufacturer shall supply sound attenuators to meet scheduled acoustical performance requirements. The attenuators shall be a three foot integral discharge attenuator.
- .9 Standard of Acceptance: Price FCGH series
 - .1 Acceptable alternate: Nailor

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.
- .2 Install fancoils as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .3 Support independently of ductwork, drywall or suspended ceiling.
- .4 Unit O/A connections to be installed with a minimum of three duct diameters of straight inlet duct, same size as inlet.
- .5 Do not use flexible inlet ducting for inlet or discharge from the unit.
- .6 Locate controls, dampers and access panels for easy access.
- .7 Mounting hardware shall be supplied by the installing contractor.
- .8 Provide each unit with shut-off valves on hydronic supply and return connections.
- .9 Threaded rod, or aircraft wire may be used to suspend the units from the building structure.
- .10 Proper rigging practice must be observed when mounting beams with aircraft wire or cable.
- .11 Aircraft wire must be rated at a minimum 75kg (165lbs) breaking strength. Minimum cable thickness shall be 1.2 (3/64")

- .12 Coordinate installation with work of other trades to achieve a neat and professional installation.
- .13 Calibrate and test fancoils with controller to fancoil manufacturer's and EMCS contractor standards prior to installation.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements

1.2 REFERENCE STANDARDS

- .1 Institute of Boiler and Radiator Manufacturers (IBR)
- .2 US Department of Commerce
 - .1 CS 140-47, Commercial Standard.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for commercial convectors and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Equipment, capacity, piping, and connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.
 - .3 Special enclosures.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for commercial convectors for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect finned tube radiation heaters from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse or recycling of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 CAPACITY

- .1 As indicated, based on entering and leaving water temperatures indicated in schedule, and 18 degrees C at entering air temperature.

2.2 CABINET CONVECTORS

- .1 Heating elements: 13mm seamless copper tubing, 1.2 mm minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, 20mm NPT end connections.
- .2 Cabinet:
 - .1 Type as indicated, 18 ga corrosion resistant steel construction, exposed corners rounded, secured removable front panel, braced and reinforced for stiffness.
 - .2 Provide access doors for valves complete with tamper proof fasteners.
 - .3 Finish cabinet with factory applied baked enamel - confirm color with Architect.
- .3 Catalogue rating: certified IBR ratings or certified commercial standard CS-140-47 .
- .4 Performance: as per drawing schedules.
- .5 Acceptable Material: Sigma, Trane, Engineered Air

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install in accordance with piping layout and reviewed shop drawings.
- .3 Provide for pipe movement during normal operation.
- .4 Maintain sufficient clearance to permit performance of service maintenance.
- .5 Check final location with Consultant if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Consultant's directive.
- .6 Valves:
 - .1 Install valves with stems upright or horizontal unless approved otherwise.
 - .2 Install isolating ball valves on inlet and balancing valves on outlet of each unit.
- .7 Venting:
 - .1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.
- .8 Clean finned tubes and comb straight.
- .9 Install flexible expansion compensators as indicated.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 08 13 - Performance Verification of HVAC Systems
- .3 Section 25 30 02 - Field Control Devices.

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 ASTM E84-11a, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .2 ASTM C916-1985 (R2007), Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C1071-05e1, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-2021, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-2021, Standard for the Installation of Warm Air Heating and Air Conditioning Systems (ANSI).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for unit heaters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Equipment, capacity and piping connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements
- .2 Operation and Maintenance Data: submit operation and maintenance data for unit heaters for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 00 10 - General Requirements

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect unit heaters from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 00 10 - General Requirements
- .5 Packaging Waste Management: remove for reuse or recycling of padding, crates, pallets, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 00 10 - General Requirements

Part 2 Products

2.1 CABINET UNIT HEATERS

- .1 Unit heater to be designed for use with low heating water temperatures (less than 130°F).
- .2 Cabinet Unit Heaters: to UL 2021.
- .3 Cabinet: type recessed, 1.6 mm thick steel with rounded exposed corners and edges, removable panels, glass fibre insulation and integral air outlet and inlet explosion proof where indicated.
 - .1 Insulation Materials: to ASTM C1071; ensure surfaces exposed to airstream have aluminum-foil facing to prevent erosion of glass fibres.
 - .1 Thickness: 25 mm.
 - .2 Thermal conductivity (k-Value): 0.037 W/m x K at 24 degrees C mean temperature.
 - .3 Fire-hazard classification flame-spread index of 25 maximum and smoke-developed index of 50 maximum to ASTM E 84.
- .4 Finish with factory applied primer coat.
- .5 Hydronic coils: hydrostatically tested to 1 MPa.
 - .1 Hot water coil: copper tube, mechanically bonded aluminum fins spaced 25 mm maximum rated 1378 kPa minimum working pressure and 104 degrees C maximum entering-water temperature. Include manual air vent and drain.
- .6 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.
- .7 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.
 - .1 Include spark free non-ferrous fan construction and explosion proof motor construction in bracket.
- .8 Filters: removable 25 mm thick permanent washable type.
- .9 Capacity: as per drawing schedules.
- .10 Control:
 - .1 On-off with speed switch key operated with integral overloads in cabinet.

- .2 Control thermostat: to Section 25 30 02 - Field Control Devices.
- .11 Standard of Acceptance: Sigma, Trane, Engineered Air

2.2 HORIZONTAL UNIT HEATERS - HYDRONIC

- .1 Unit heater to be designed for use with low heating water temperatures (less than 130°F).
- .2 Casing: 1.6 mm thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.
- .3 Coils: hydrostatically test to 1 MPa.
 - .1 Hot water coil: copper tube, mechanically bonded aluminum fins spaced 25 mm maximum rated 1378 kPa minimum working pressure and 104 degrees C maximum entering-water temperature. Include manual air vent and drain.
- .4 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.
- .5 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor explosion proof supports.
- .6 Air outlet: four-way adjustable louvres.
- .7 Capacity: as per drawing schedules.
- .8 Control thermostat: to Section 25 30 02 - Field Control Devices.
- .9 Standard of Acceptance: Sigma, Trane, Engineered Air

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Include double swing pipe joints as indicated.
- .3 Check final location with Consultant if different from that indicated prior to installation.
 - .1 Should deviations beyond allowable clearances arise, request and follow Consultant's directive.
- .4 Hot water units: for each unit, install ball valve on inlet and calibrated balancing valve on outlet of each unit. Install drain valve at low point.
 - .1 Install manual air vent at high point.
- .5 Clean finned tubes and comb straight.
- .6 Provide supplementary suspension steel as required.
- .7 Install thermostats in locations indicated.
- .8 Before acceptance, set discharge patterns and fan speeds to suit requirements.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 00 10 - General Requirements
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements
- .3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 00 10 - General Requirements

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.3 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by unit heaters installation.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:
 - .1 Start-up testing and verification of systems.
 - .2 Check out demonstration or proper operation of components.
 - .3 On-site operational tests.

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 01 91 13.13 - Commissioning Plan
- .3 Section 01 91 13.16 - Commissioning Forms
- .4 Section 01 91 14 - Facility Commissioning Mechanical
- .5 Section 01 91 15 - Facility Commissioning Electrical
- .6 Section 23 05 03 - Mechanical Start-up
- .7 Section 23 08 13 - Performance Verification of HVAC Systems
- .8 Section 25 05 01 - EMCS: General Requirements.
- .9 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

1.3 DEFINITIONS

- .1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
- .2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.
- .3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
 - .1 Outage of main power supply in excess of back-up power sources, provided that:
 - .1 Automatic initiation of back-up was accomplished.
 - .2 Automatic shut-down and re-start of components was as specified.
 - .2 Failure of communications link, provided that:
 - .1 Controller automatically and correctly operated in stand-alone mode.
 - .2 Failure was not due to failure of any specified EMCS equipment.
 - .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
 - .1 System recorded said fault.
 - .2 Equipment defaulted to fail-safe mode.

- .3 AEL of total of all input sensors and output devices is at least 99 % during test period.

1.4 ACRONYMS

- .1 AI - Analog Input.
- .2 AO - Analog Outoput.
- .3 AEL - Average Effectiveness Level.
- .4 BECC – Building Environmental Level
- .5 CDL – Control Description Logic
- .6 DI – Digital Input
- .7 DO – Digital Output
- .8 DP – Differential Pressure
- .9 EMCS – Energy Monitoring & Control System
- .10 GPC – General Purpose Controller
- .11 UC – Unitary Controller
- .12 POT – Portable Operator Terminal
- .13 OWS – Operator's Work Station
- .14 PCU – Programmable Control Unit
- .15 SP – Static Pressure
- .16 VAV – Variable Air Volume

1.5 GENERAL

- .1 Work Includes:
 - .1 Pre-installation tests.
 - .2 Completion tests.
 - .3 EMCS startup.
 - .4 Commissioning.
- .2 Coordinate with all other trades.

1.6 DESIGN REQUIREMENTS

- .1 Confirm with Consultant that Design Criteria and Design Intents are still applicable.
- .2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.7 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 00 10 - General Requirements
- .2 Final Report: submit report to Consultant.
 - .1 Include measurements, final settings and certified test results.
 - .2 Bear signature of commissioning technician and supervisor
 - .3 Report format to be approved by Consultant before commissioning is started.

- .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Consultant in accordance with Section 01 00 10 - General Requirements
- .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.8 CLOSEOUT SUBMITTALS

- .1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Consultant before interim acceptance in accordance with Section 01 00 10 - General Requirements

1.9 COMMISSIONING

- .1 Prior to commissioning, verify and document that EMCS systems are operational.
- .2 Do commissioning in accordance with Section 01 91 13.13 - Commissioning Plan and Section 01 91 14 - Facility Commissioning Mechanical
- .3 Carry out commissioning under direction of Consultant and in presence of Commissioning Agent.
- .4 Inform, and obtain approval from, Consultant in writing at least 14 days prior to commissioning or each test. Indicate:
 - .1 Location and part of system to be tested or commissioned.
 - .2 Testing/commissioning procedures, anticipated results.
 - .3 Names of testing/commissioning personnel.
- .5 Correct deficiencies, re-test in presence of Consultant until satisfactory performance is obtained.
- .6 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .7 Load system with project software.
- .8 Perform tests as required.

1.10 COMPLETION OF COMMISSIONING

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Consultant.

1.11 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

- .1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

Part 2 Products

2.1 EQUIPMENT

- .1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.
- .2 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios or utilize cell phones.

- .3 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.
- .4 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.
- .5 Locations to be approved, readily accessible and readable.
- .6 Application: to conform to normal industry standards.

Part 3 Execution

3.1 START-UP

- .1 Coordinate start-up of EMCS with the start-up requirements of Division 22 and 23 systems and equipment specified within the respective Division 22 and 23 sections.
- .2 Coordinate requirements of this section with Section 23 05 03 - Mechanical Start-up.

3.2 PROCEDURES

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by the Consultant.
- .3 Commission integrated systems using procedures prescribed by Consultant.
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.3 FIELD QUALITY CONTROL

- .1 Pre-Installation Testing.
 - .1 General: consists of field tests of equipment just prior to installation.
 - .2 Testing may be on site or at Contractor's premises as approved by Consultant.
 - .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.
 - .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
 - .5 Additional instruments to include:
 - .1 DP transmitters.
 - .2 VAV supply duct SP transmitters.
 - .3 DP switches used for dirty filter indication and fan status.
 - .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp metre at source and to BECC.

- .7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
- .8 Consultant to mark instruments tracking within 0.5 % in both directions as "approved for installation".
- .9 Transmitters above 0.5 % error will be rejected.
- .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.
 - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
 - .2 Include following activities:
 - .1 Test and calibrate field hardware including stand-alone capability of each controller.
 - .2 Verify each A-to-D convertor.
 - .3 Test and calibrate each AI using calibrated digital instruments.
 - .4 Test each DI to ensure proper settings and switching contacts.
 - .5 Test each DO to ensure proper operation and lag time.
 - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
 - .7 Test operating software.
 - .8 Test application software and provide samples of logs and commands.
 - .9 Verify each CDL including energy optimization programs.
 - .10 Debug software.
 - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
 - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Consultant. This document will be used in final startup testing.
 - .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Consultant and provide:
 - .1 2 technical personnel capable of re-calibrating field hardware and modifying software.
 - .2 Detailed daily schedule showing items to be tested and personnel available.
 - .3 Consultant's acceptance signature to be on executive and applications programs.
 - .4 Commissioning to commence during final startup testing.
 - .5 O&M personnel to assist in commissioning procedures as part of training.
 - .6 Commissioning to be supervised by qualified supervisory personnel and Consultant.
 - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.

- .8 Operate systems as long as necessary to commission entire project.
- .9 Monitor progress and keep detailed records of activities and results.
- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
 - .1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
 - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
 - .2 Test to last at least 30 consecutive 24 hour days.
 - .3 Tests to include:
 - .1 Demonstration of correct operation of monitored and controlled points.
 - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
 - .4 System will be accepted when:
 - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
 - .2 Requirements of Contract have been met.
 - .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
 - .6 Correct defects when they occur and before resuming tests.
- .5 Consultant to verify reported results.

3.4 ADJUSTING

- .1 Final adjusting: upon completion of commissioning as reviewed by Consultant, set and lock devices in final position and permanently mark settings.

3.5 DEMONSTRATION

- .1 Demonstrate to Consultant operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 00 10 - General Requirements

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED REQUIREMENTS

- .1 Section 01 79 00.13 - Demonstration and Training for Building Commissioning
- .2 Section 01 00 10 - General Requirements
- .3 Section 25 01 01 - EMCS: General Requirements.

1.3 DEFINITIONS

- .1 CDL - Control Description Logic.
- .2 For additional acronyms and definitions refer to Section 25 01 01 - EMCS: General Requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 00 10 - General Requirements, supplemented and modified by requirements of this Section.
- .2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Consultant 30 days prior to anticipated date of beginning of training.
 - .1 List name of trainer, and type of visual and audio aids to be used.
 - .2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.
- .3 Submit reports within one week after completion of Phase 2 training program that training has been satisfactorily completed.

1.5 QUALITY ASSURANCE

- .1 Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2 Consultant reserves right to approve instructors.

1.6 INSTRUCTIONS

- .1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2 Training to be project-specific.

1.7 TIME FOR TRAINING

- .1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

- .2 In addition to the time required under clause 1.9 below, provide addition training on operation and maintenance of the following devices
 - .1 Space thermostats, with and without CO2 sensors: minimum 30 minutes
 - .2 Thermal Energy Meters: minimum 1 hour
 - .3 Watthour meters and Current Transformers: minimum 30 minutes
 - .4 Air flow measuring stations (velocity pressure sensors): minimum 30 minutes
 - .5 Ducted Fume Hood Controller and Face Velocity Monitor/Alarm Device: minimum 2 hours

1.8 TRAINING MATERIALS

- .1 Provide equipment, visual and audio aids, and materials for classroom training.
- .2 Supply manual for each trainee, describing in detail data included in each training program.
 - .1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

1.9 TRAINING PROGRAM

- .1 To be in 2 phases over 6 month period.
- .2 Phase 1: 3 day program to begin before 30 day test period at time mutually agreeable to Contractor, Consultant and Owner's Representative.
 - .1 Train O&M personnel in functional operations and procedures to be employed for system operation.
 - .2 Supplement with on-the-job training during 30 day test period.
 - .3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
 - .4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
- .3 Phase 2: 3 day program to begin 4 weeks after acceptance for operators and equipment maintenance personnel.
 - .1 Provide multiple instructors on pre-arranged schedule. Include at least following:
 - .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
 - .2 Equipment maintenance training: provide personnel with 2 days training within 5 day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.

1.10 ADDITIONAL TRAINING

- .1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.11 MONITORING OF TRAINING

- .1 Consultant and/or Commissioning Authority to monitor training program and may modify schedule and content.

Part 2 Products - Not Used

Part 3 Execution - Not Used

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to EMCS Sections.

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 09 91 99 - Painting.
- .3 Section 21 05 00 - Common Work Results for Fire Suppression
- .4 Section 22 05 00 - Common Work Results for Plumbing
- .5 Section 23 05 00 - Common Work Results for HVAC
- .6 Section 26 05 00 - Common Work Results for Electrical
- .7 Section 25 05 02 - EMCS: Submittals & Review Process
- .8 Section 25 05 02 - EMCS: Project Record Documents

1.3 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
 - .1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE).
 - .1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE STD 135-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA Group).
 - .1 CAN/CSA-Z234.1-89 (R1995), Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
 - .1 CEA-709.1-B-2002, Control Network Protocol Specification.
- .6 Electrical and Electronic Manufacturers Association (EEMAC).
 - .1 EEMAC 2Y-1-1958, Light Grey Colour for Indoor Switch Gear.

1.4 ABBREVIATIONS AND ACRONYMS

- .1 Acronyms used in EMCS:
 - .1 AEL - Average Effectiveness Level
 - .2 AI - Analog Input

- .3 AIT - Agreement on International Trade
- .4 AO - Analog Output
- .5 BACnet - Building Automation and Control Network.
- .6 BC(s) - Building Controller(s).
- .7 BECC - Building Environmental Control Centre.
- .8 CAD - Computer Aided Design.
- .9 CDL - Control Description Logic.
- .10 CDS - Control Design Schematic.
- .11 COSV - Change of State or Value.
- .12 CPU - Central Processing Unit.
- .13 DI - Digital Input.
- .14 DO - Digital Output.
- .15 DP - Differential Pressure.
- .16 ECU - Equipment Control Unit.
- .17 EMCS - Energy Monitoring and Control System.
- .18 HVAC - Heating, Ventilation, Air Conditioning.
- .19 IDE - Interface Device Equipment.
- .20 I/O - Input/Output.
- .21 ISA - Industry Standard Architecture.
- .22 LAN - Local Area Network.
- .23 LCU - Local Control Unit.
- .24 MCU - Master Control Unit.
- .25 NC - Normally Closed.
- .26 NO - Normally Open.
- .27 OS - Operating System.
- .28 O&M - Operation and Maintenance.
- .29 OWS - Operator Work Station.
- .30 PC - Personal Computer.
- .31 PCI - Peripheral Control Interface.
- .32 PID - Proportional, Integral and Derivative.
- .33 RAM - Random Access Memory.
- .34 SP - Static Pressure.
- .35 ROM - Read Only Memory.
- .36 TCU - Terminal Control Unit.
- .37 USB - Universal Serial Bus.
- .38 UPS - Uninterruptible Power Supply.
- .39 VAV - Variable Air Volume.

1.5 DEFINITIONS

- .1 Point: may be logical or physical.
 - .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
 - .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
- .2 Point Name: composed of two parts, point identifier and point expansion.
 - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.
 - .1 Area descriptor: building or part of building where point is located.
 - .2 System descriptor: system that point is located on.
 - .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.
 - .2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
 - .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
 - .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
- .3 Point Object Type: points fall into following object types:
 - .1 AI (analog input).
 - .2 AO (analog output).
 - .3 DI (digital input).
 - .4 DO (digital output).
 - .5 Pulse inputs.
- .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
 - .1 Printouts: to ANSI/IEEE 260.1.
 - .2 Refer also to Section 25 05 54 - EMCS: Identification.

1.6 SYSTEM DESCRIPTION

- .1 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
 - .1 Building Controllers.
 - .2 Control devices as listed in I/O point summary tables.
 - .3 OWS(s).

- .4 Data communications equipment necessary to effect EMCS data transmission system.
- .5 Field control devices.
- .6 Software/Hardware complete with full documentation.
- .7 Complete operating and maintenance manuals.
- .8 Training of personnel.
- .9 Acceptance tests, technical support during commissioning, full documentation.
- .10 Wiring interface co-ordination of equipment supplied by others.
- .11 Miscellaneous work as specified in these sections and as indicated.
- .2 Design Requirements:
 - .1 Design and provide conduit and wiring linking elements of system.
 - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Consultant prior to installation.
 - .3 Location of controllers as reviewed by Consultant prior to installation.
 - .4 Provide utility power to EMCS and emergency power to EMCS as indicated.
 - .5 Metric references: in accordance with CAN/CSA Z234.1.
- .3 Language Operating Requirements:
 - .1 Provide English operator selectable access codes.
 - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
 - .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.
 - .4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
 - .5 Include, in English :
 - .1 Input and output commands and messages from operator-initiated functions, alarms and field related changes as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definitions).
 - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.
 - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.7 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 25 05 02 - EMCS: Submittals & Review Process and Section 01 00 10 - General Requirements.

- .2 Provide copies of all drawings, programming, settings, simulations and other system design documents in their native file type.
- .3 Quality Control:
 - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
 - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
 - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 01 00 10 - General Requirements. Label or listing of specified organization is acceptable evidence.
 - .4 In lieu of such evidence, submit certificate from testing organization, approved by Consultant, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
 - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
 - .6 Permits and fees: in accordance with general conditions of contract.
 - .7 Submit certificate of acceptance from authority having jurisdiction to Consultant.
 - .8 Existing devices intended for re-use: submit test report.

1.8 QUALITY ASSURANCE

- .1 Have local office within 1500 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,
- .2 Provide record of successful previous installations when submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Provide 7 year guarantee of availability of spare parts after obsolescence.
- .4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Consultant with schedule within 2 weeks after award of Contract.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Separate for reuse and recycling and place in designated containers Metal and Plastic waste in accordance with Waste Management Plan.

- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with Regional and Municipal, and CEPA regulations.
- .7 Label location of salvaged material's storage areas and provide barriers and security devices.
- .8 Ensure emptied containers are sealed and stored safely.
- .9 Divert unused metal materials from landfill to metal recycling facility as approved by Consultant.
- .10 Fold up plastic and metal banding, flatten and place in designated area for recycling.

1.10 EMCS COST BREAKDOWN

- .1 Provide detailed breakdown of EMCS Sub-Contractor's work prior to first progress claim. Breakdown to be itemized with separate labour and material listing against each item of the contract breakdown. After approval by Consultant cost breakdown will be used as basis for progress payment.
- .2 Breakdown and subsequent Progress Claims are to be itemized with separate labour and material listing against each item of the contract breakdown where indicated as required.
- .3 Progress claims will not be reviewed if they do not breakout materials and labour where appropriate.
- .4 EMCS Contract Breakdown:
 - .1 General
 - .1 Mobilization / Demobilization
 - .2 Administration & Safety
 - .3 Shop drawings
 - .2 Installation
 - .1 Wiring & devices
 - .2 Panels & interfaces
 - .3 Graphics
 - .3 Documentation & Closeout
 - .1 Performance Verification and optimization
 - .2 Commissioning
 - .3 Operation & Maintenance Manuals
 - .4 As-built drawings
 - .5 Training
 - .6 Warranty Review

Part 2 Products

2.1 EQUIPMENT

- .1 Control Network Protocol: to ASHRAE STD 135.

- .2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

2.2 ADAPTORS

- .1 Provide adaptors between metric and imperial components.

2.3 ACCEPTABLE SYSTEM

- .1 The existing university campus utilizes a Johnson Controls Metasys System. This system is not to be expanded to include Polaris. A new standalone system is required for Polaris. The new system for Polaris shall be compatible with and capable of interfacing with the existing university system where required.
- .2 Acceptable System: Johnson Controls Metasys
 - .1 Acceptable alternates: Honeywell Niagara, Siemens, Delta Controls.

Part 3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

- .1 Installation: to manufacturer's recommendations.

3.2 PAINTING

- .1 Painting: in accordance with Section 09 91 99 - Painting, supplemented as follows:
 - .1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
 - .2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.
 - .3 Clean and prime exposed hangers, racks, fastenings, and other support components.
 - .4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 25 05 01 - EMCS: General Requirements.
- .3 Section 25 05 03 - EMCS: Project Record Documents
- .4 Section 25 08 20 - EMCS: Warranty and Maintenance.

1.3 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 ACTION AND INFORMATION SUBMITTALS

- .1 Submittals in accordance with Section 01 00 10 - General Requirements and coordinate with requirements in this Section.
- .2 Shop Drawings to consist of 1 soft copy of design documents, shop drawings, product data and software.
- .3 Soft copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number. Provide divider sheets and bookmarks in PDFs.
- .4 Soft copy to be in PDF and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

1.5 PRELIMINARY SHOP DRAWING REVIEW

- .1 Submit preliminary shop drawings within 60 working days of award of contract and include following:
 - .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
 - .2 Detailed system architecture showing all points associated with each controller including signal levels, pressures where new EMCS ties into existing control equipment.
 - .3 Spare point capacity of each controller by number and type.
 - .4 Controller locations.
 - .5 Auxiliary control cabinet locations.

- .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
- .7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
- .8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.
- .9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.

1.6 DETAILED SHOP DRAWING REVIEW

- .1 Submit detailed shop drawings within 90 working days after award of contract and before start of installation and include following:
 - .1 Corrected and updated versions of submissions made during preliminary review.
 - .2 Wiring diagrams.
 - .3 Piping diagrams and hook-ups.
 - .4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
 - .5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
 - .1 Sensing element type and location.
 - .2 Transmitter type and range.
 - .3 Associated field wiring schematics, schedules and terminations.
 - .4 Complete Point Name Lists.
 - .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
 - .6 Software and programming details associated with each point.
 - .7 Manufacturer's recommended installation instructions and procedures.
 - .8 Input and output signal levels or pressures where new system ties into existing control equipment.
 - .6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
 - .7 Graphic system schematic displays of air systems with point identifiers and textual description of system, and typical floor plans as specified.
 - .8 Graphic system schematic displays of hydronic systems with point identifiers and textual description of system, and typical floor plans as specified.
 - .9 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
 - .10 Listing and example of specified reports.

- .11 Listing of time of day schedules.
- .12 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
- .13 Type and size of memory with statement of spare memory capacity.
- .14 Full description of software programs provided.
- .15 Sample of "Operating Instructions Manual" to be used for training purposes.
- .16 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.7 QUALITY ASSURANCE

- .1 Preliminary Design Review Meeting: Convene meeting within 75 working days of award of contract to:
 - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
 - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
 - .3 Review interface requirements of materials supplied by others.
 - .4 Review "Sequence of Operations".
- .2 Contractor's programmer to attend meeting.
- .3 Consultant retains right to revise sequence or subsequent CDL prior to software finalization without cost to Consultant.

Part 2 Products - Not Used

Part 3 Execution - Not Used

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes
 - .1 Requirements and procedures for final control diagrams and operation and maintenance (O M) manual, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning
- .3 Section 25 01 12 - EMCS: Training
- .4 Section 25 05 01 - EMCS: General Requirements
- .5 Section 25 05 02 - EMCS: Submittals & Review Process
- .6 Section 25 08 20 - EMCS: Warranty and Maintenance

1.3 DEFINITIONS

- .1 BECC - Building Environmental Control Centre.
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.4 ACTION AND INFORMATION SUBMITTALS

- .1 Submittals in accordance with Section 01 00 10 - General Requirements, supplemented and modified by requirements of this Section.
- .2 Submit Record Documents to Consultant in English.
- .3 Hard copies, binders: expandable metal post, hard covered, loose leaf 219 x 279mm with embossed spine and face.
 - .1 Binders to be 2/3 maximum full.
 - .2 Provide index to full volume in each binder.
 - .3 Identify contents of each manual on cover and spine.
 - .4 Provide Table of Contents in each manual.
 - .5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.
- .4 Soft copy: PDF with dividers and bookmarks

1.5 AS-BUILTS

- .1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
 - .1 Changes to contract documents as well as addenda and contract extras.

- .1 Include full as-building drawings of sequences and control schematics (including any single line diagrams and details).
- .2 Changes to interface wiring.
- .3 Routing of conduit, wiring and control air lines associated with EMCS installation.
- .4 Locations of obscure devices to be indicated on drawings.
- .5 Listing of alarm messages.
- .6 Panel/circuit breaker number for sources of normal/emergency power.
- .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
- .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .9 Basic system design and full documentation on system configuration.
- .2 Submit for final review by Consultant.
- .3 Provide before acceptance 4 Hard and 1 soft copy incorporating changes made during final review.

1.6 O&M MANUALS

- .1 Custom design O M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
- .2 Provide 1 complete sets of hard copy and 1 soft copy prior to system or equipment tests.
- .3 Provide 4 complete sets of hard copies and 1 soft copy after substantial completion and before building handover to Owner.
- .4 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.
- .5 Functional description of theory of operation.
 - .1 Design philosophy.
 - .2 Specific functions of design philosophy and system.
 - .3 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator.
 - .4 Tests or self-test of data link integrity.
 - .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
 - .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.
- .6 System operation to include:
 - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
 - .2 Operation of computer peripherals, input and output formats.

- .3 Emergency, alarm and failure recovery.
- .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.
- .7 Software to include:
 - .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
 - .2 Detailed descriptions of program requirements and capabilities.
 - .3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.
 - .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
 - .5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.
 - .6 Software for each Controller and single section referencing Controller common parameters and functions.
- .8 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/ replacement of system hardware.
- .9 System configuration document:
 - .1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.
 - .2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
- .10 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

Part 2 Products - Not Used

Part 3 Execution - Not Used

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 05 53 - Identification for HVAC Piping and Equipment
- .3 Section 25 05 01 - EMCS: General Requirements.

1.3 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA Group).
 - .1 CSA C22.1 (latest edition), The Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

1.4 DEFINITIONS

- .1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.5 SYSTEM DESCRIPTION

- .1 Language Operating Requirements: provide identification for control items in English.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 25 05 02 - EMCS: Submittals & Review Process and Section 01 00 10 - General Requirements supplemented and modified by requirements of this Section.
- .2 Submit to Consultant for approval samples of nameplates, identification tags and list of proposed wording.

Part 2 Products

2.1 NAMEPLATES FOR PANELS

- .1 Identify by Plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.
- .2 Sizes: 25 x 67 mm minimum.
- .3 Lettering: minimum 7 mm high, black.
- .4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

- .1 Identify by plastic encased cards attached by chain.
- .2 Sizes: 50 x 100 mm minimum.

- .3 Lettering: minimum 5 mm high produced from laser printer in black.
- .4 Data to include: point name and point address.
- .5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

- .1 Identify by stick-on labels using point identifier.
- .2 Location: as directed by Consultant.
- .3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

- .1 Equipment including motors, starters under remote automatic control: supply and install orange colored signs warning of automatic starting under control of EMCS.
- .2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS".

2.5 WIRING

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 CONDUIT

- .1 Colour code EMCS conduit.
- .2 Pre-paint box covers and conduit fittings.
- .3 Coding: use fluorescent orange paint and confirm colour with Consultant during "Preliminary Design Review".

Part 3 Execution

3.1 NAMEPLATES AND LABELS

- .1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 25 05 01 - EMCS: General Requirements.
- .3 Section 25 05 02 - EMCS: Submittals & Review Process

1.3 DEFINITIONS

- .1 BC(s) - Building Controller(s).
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 25 05 02 - EMCS: Submittals & Review Process and Section 01 00 10 - General Requirements
- .2 Submit detailed preventative maintenance schedule for system components to Consultant.
- .3 Submit detailed inspection reports to Consultant.
- .4 Submit dated, maintenance task lists to Consultant and include the following sensor and output point detail, as proof of system verification:
 - .1 Point name and location.
 - .2 Device type and range.
 - .3 Measured value.
 - .4 System displayed value.
 - .5 Calibration detail
 - .6 Indication if adjustment required,
 - .7 Other action taken or recommended.
- .5 Submit network analysis report showing results with detailed recommendations to correct problems found.
- .6 Records and logs: in accordance with Section 01 00 10 - General Requirements
 - .1 Maintain records and logs of each maintenance task on site.
 - .2 Organize cumulative records for each major component and for entire EMCS chronologically.

- .3 Submit records to Consultant, after inspection indicating that planned and systematic maintenance have been accomplished.
- .7 Revise and submit to Consultant in accordance with Section 01 00 10 - General Requirements "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.5 MAINTENANCE SERVICE DURING WARRANTY PERIOD

- .1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
- .2 Emergency Service Calls:
 - .1 Initiate service calls when EMCS is not functioning correctly.
 - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
 - .3 Furnish Consultant and Owner with telephone number where service personnel may be reached at any time.
 - .4 Service personnel to be on site ready to service EMCS within 12 hours after receiving request for service.
 - .5 Perform Work continuously until EMCS restored to reliable operating condition.
- .3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.
- .4 Work requests: record each service call request, when received separately on approved form and include:
 - .1 Serial number identifying component involved.
 - .2 Location, date and time call received.
 - .3 Nature of trouble.
 - .4 Names of personnel assigned.
 - .5 Instructions of work to be done.
 - .6 Amount and nature of materials used.
 - .7 Time and date work started.
 - .8 Time and date of completion.
- .5 Provide system modifications in writing.
 - .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Consultant.

1.6 SERVICE CONTRACTS

- .1 Provide in-depth technical expertise and assistance to Consultant and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures.
- .2 Requirements for service contracts are to be coordinated with the Owner and to include:
 - .1 Annual verification of field points for operation and calibration.
 - .2 2 visits per year.

- .3 10 responses to emergency calls during day, per year.
- .4 5 responses to emergency calls during silent hours per year.
- .5 Silent hours defined as 1630h to 0800h.
- .6 Complete inventory of installed system.

Part 2 Products

2.1 WARRANTY PERIOD

- .1 Warranty Period to be 2 years from the date of substantial completion for EMCS items as detailed in Division 25.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

- .1 Perform as minimum (2) two minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Consultant as described in Submittal article.
- .2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.
- .3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
 - .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
 - .2 Calibrate each field input/output device in accordance with CSA Z204.
 - .3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.
- .4 Minor inspections to include, but not limited to:
 - .1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
 - .2 Check equipment cooling fans as required.
 - .3 Review system performance with Consultant to discuss suggested or required changes.
 - .4 Provide report summarizing inspection findings, adjustments, and recommendations.
- .5 Major inspections to include, but not limited to:
 - .1 Minor inspection.
 - .2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
 - .3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
 - .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
 - .5 Provide mechanical adjustments, and necessary maintenance on printers.
 - .6 Run system software diagnostics as required.

- .7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
 - .1 Perform network analysis and provide report as described in Submittal article.
- .8 Provide report summarizing inspection findings, adjustments, and recommendations.
- .6 Rectify deficiencies revealed by maintenance inspections and environmental checks.
- .7 Continue system debugging and optimization.
- .8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
 - .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).

1.2 RELATED REQUIREMENTS

- .1 Section 25 05 01 - EMCS - General Requirements

1.3 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA Group).
 - .1 CSA T529-95 (R2000), Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
 - .2 CSA T530-99 (R2004), Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).
- .2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.
 - .1 IEEE Std 802.3™-, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.
- .3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 TIA/EIA-568-March 2004, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.
 - .2 TIA/EIA-569-A-December 2001, Commercial Building Standard for Telecommunications Pathways and Spaces.
- .4 Treasury Board Information Technology Standard (TBITS).
 - .1 TBITS 6.9-2000, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

1.4 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS - General Requirements.

1.5 SYSTEM DESCRIPTION

- .1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529.
 - .1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.
 - .2 Allow for future expansion of network, with selection of networking technology and communication protocols.
- .2 Data communication network to include, but not limited to:
 - .1 EMCS-LAN.

- .2 Modems.
- .3 Network interface cards.
- .4 Network management hardware and software.
- .5 Network components necessary for complete network.

1.6 DESIGN REQUIREMENTS

- .1 EMCS Local Area Network (EMCS-LAN).
 - .1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.
 - .2 Each EMCS-LAN to be capable of supporting at least 50 devices.
 - .3 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
 - .4 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.
 - .5 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
 - .6 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.
- .2 Dynamic Data Access.
 - .1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
 - .2 Access to data to be based upon logical identification of building equipment.
- .3 Network Medium.
 - .1 Network medium: shielded twisted cable, compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

Part 2 Products - Not Used

Part 3 Execution - Not Used

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS), including primary, secondary, portable and remote OWS's.

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 25 05 01 - EMCS: General Requirements.
- .3 Section 25 05 02 - EMCS: Submittals & Review Process
- .4 Section 25 05 20 - EMCS: Warranty and Maintenance.
- .5 Section 25 30 01 - EMCS: Building Controllers
- .6 Section 25 30 02 - EMCS: Field Control Devices
- .7 Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation

1.3 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.
- .2 Portable OWS: used as remote access OWS with same capabilities as primary OWS including graphic display.
- .3 Remote Auxiliary OWS: performs identical user interface functions as primary OWS.

1.4 OWS SYSTEM DESCRIPTION

- .1 Consists of commercially available personal computer in current production, with sufficient memory and processor capacity to perform functions specified.
- .2 Primary OWS to include:
 - .1 Report printer.
 - .2 Colour graphics printer.
 - .3 Desks, furniture.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 25 05 02 - EMCS: Submittals & Review Process and Section 01 00 10 - General Requirements

1.6 ENVIRONMENTAL CONDITIONS

- .1 OWS to operate in conditions of 10 degrees C to 32 degrees C and 20 % to 90 % non-condensing RH.

1.7 MAINTENANCE

- .1 Provide maintenance in accordance with Section 25 05 20 - EMCS: Warranty and Maintenance.

Part 2 Products

2.1 OWS HARDWARE

- .1 PC system to include:
 - .1 Internal clock.
 - .1 Uninterruptible clock: accuracy of plus or minus 5 seconds/month, capable of deriving year/month/day/hour/minute/second.
 - .2 Rechargeable batteries: to provide minimum 48 hours clock operation in event of power failure.
 - .2 Asynchronous interfaces for connection to listed peripheral devices including LAN and remote devices.
- .2 Power supply unit to accept 120 V 60 Hz source and include line surge and low voltage protection for processor and its peripherals.
- .3 PC Components
 - .1 Intel Core™ i5 Processor (2.66GHz, 4M, 1333MHZ FSB) based desk-top personal computer complete with:
 - .1 Energy Smart and Energy Star 4.0
 - .2 16GB RAM minimum
 - .3 Integrated Intel Graphics
 - .4 Storage: SSD, 512 GB, M.2 2230, PCIe NVMe, Class 35
 - .5 Integrated Intel Gigabit NIC
 - .6 USB 5-button Premium Mouse
 - .7 USB Enhanced Multimedia Keyboard
 - .8 21 inch UltraSharp Flat Panel, Adjustable Stand, DVI/DP
 - .9 8x DVD +/-RW Drive Dual Layer
 - .10 Provide LAN card to allow connection directly on the primary bus linking all SCU's.
 - .2 Standard of Acceptance: Dell OptiPlex Small Form Factor series, Dell Precision Small Form Factor or Compact series desktop computer
- .4 Connectivity
 - .1 Provide internet connection to OWS PC for both local and remote monitoring and control.
 - .2 Provide required network adapter(s) or router(s) to allow OWS to interface with BACnet system.
- .5 Include UPS to provide 15 minutes minimum operation of PC, screen, and communication and peripheral devices; applies to fixed (non portable) OWSs and peripherals.

2.2 PRINTERS

- .1 Colour graphics printer include following features:
 - .1 Ink-jet technology capable of printing high quality colour images at speed of 4 pages per minute.
 - .2 Black cartridge to be separate cartridge from red green blue cartridge.
 - .3 Minimum colour resolution 2400 by 1200 dpi.
 - .4 Minimum black and white resolution 1200 by 1200 dpi.
 - .5 Minimum 32 MB RAM.
- .2 Include one box of 8.5 X 11" and one box of 8.5 X 14" paper.

2.3 CONTROL DESK CONSOLE

- .1 Capable of accommodating OWS and peripheral equipment specified with provision for operator desk work space.
- .2 Layout: as indicated.
- .3 Desk: steel office type, standard sizes 1 m x 2 m, factory-made, computer type, for equipment mounting, with drawers on one side.
 - .1 Keyboards to be in separate pull-out drawer.
 - .2 Include above desk shelving to support contractor supplied manuals.
- .4 Chair: upholstered, swivel type, with adjustable arms, back and seat, pneumatic seat height adjustment and 5 castors.

2.4 OPERATING SYSTEM (OS) OR EXECUTIVE

- .1 OS to support complement of hardware terminals and software programs specified.
- .2 OS to be true multitasking operating environment.
 - .1 MS DOS or PC DOS based software platforms not permitted.
- .3 OWS software to operate in "Windows" based operating environment: Windows 10 or 11 based system.

2.5 OWS CONTROL SOFTWARE

- .1 OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer to peer communication occurring at MCU to MCU device level.
 - .1 Graphics control software to be accessible from OWS via web browser.
- .2 Time Synchronization Module.
 - .1 System to provide Time Synchronization of real-time clocks in controllers.
 - .2 System to perform this feature on regular scheduled basis and on operator request.
- .3 User Display Interface Module.
 - .1 OWS software to support "Point Names" as defined in Section 25 05 01 - EMCS: General Requirements.
 - .2 Upon operator's request in either text, graphic or table mode, system to present condition of single point, system, area, or connected points on system to OWS.

Display analog values digitally to 1 place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. For systems supporting COSV, refresh rate of screen data not to exceed 5 seconds from time of field change and system is to execute supervisory background scan every 20 seconds to verify point data value. For other systems refresh rate not to exceed 5 seconds for points displayed. Initial display of new system graphic display (with up to 30 active points), including presentation of associated dynamic data not to exceed 8 seconds.

- .4 General Event Log Module: to record system activities occurring at OWS or elsewhere in system including:
 - .1 Operator Log-in from user interface device.
 - .2 Communication messages: errors, failures and recovery.
 - .3 Event notifications and alarms by category.
 - .4 Record of operator initiated commands.
- .5 General Event Log:
 - .1 Hold minimum of 13 months information and be readily accessible to operator.
 - .2 Able to be archived as necessary to prevent loss of information.
- .6 Operator Control Software Module: to support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user; dynamic displays, textual displays, and graphic displays to display logging and trending of system information and following tasks:
 - .1 Automatic logging of digital alarms and change of status messages.
 - .2 Automatic logging of analog alarms.
 - .3 System changes: alarm limits, set-points, alarm lockouts.
 - .4 Display specific point values, states as selected.
 - .5 Provide reports as requested and on scheduled basis when required.
 - .6 Display graphics as requested, and on alarm receptions (user's option).
 - .7 Display list of points within system.
 - .8 Display list of systems within building.
 - .9 Direct output of information to selected peripheral device.
 - .10 On-line changes:
 - .1 Alarm limits.
 - .2 Setpoints.
 - .3 Deadbands.
 - .4 Control and change of state changes.
 - .5 Time, day, month, year.
 - .6 Control loop configuration changes for controller-based CDLs.
 - .7 Control loop tuning changes.
 - .8 Schedule changes.

-
- .9 Changes, additions, or deletions, of points, graphics, for installed and future systems.
 - .11 According to assigned user privileges (password definition) following functions are to be supported:
 - .1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by operator.
 - .2 Requests for status, analog values, graphic displays, logs and controls to be through user interface screens.
 - .12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.
 - .7 Dial-up host Module for off site OWSs.
 - .1 Operators at dial-up OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.
 - .2 Operator to be able to access remote buildings by selection of facility by its logical name. Dial-up module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.
 - .3 Local OWS may serve as dial-up host for remotely connecting OWSs, remote controllers or networks. Alarms and data file transfers handled via dial-up transactions must not interfere with local LAN activity. LAN activity not to prevent work-station from handling incoming calls.
 - .8 Message Handling Module - and Error Messages: to provide message handling for following conditions:
 - .1 Message and alarm buffering to prevent loss of information.
 - .2 Error detection correction and retransmission to guarantee data integrity.
 - .3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of equipment to respond to requests or commands and failure of communications between EMCS devices.
 - .4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.
 - .9 Access ControlModule.
 - .1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. Following is preferred format of progression of password levels:
 - .1 Guest: no password data access and display only.
 - .2 Operator Level: full operational commands including automatic override.
 - .3 Technician: data base modifications.
 - .4 Programmer: data base generation.
 - .5 Highest Level: system administration - password assignment addition, modification.

- .2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 5 minutes.
- .10 Trend Data Module: includes historical data collection utility, trend data utility, control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate.
 - .1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate 5-480 minutes. Samples to include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least 13 month capacity.
 - .2 Trend data utility: continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of following point object types - DI, DO, AI, AO set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of 05 seconds to 3600 seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum 168 hours basis in temporary storage until removed from trend data list by operator. Option to archive data before overwriting to be available.
 - .3 Control loop plot utility: for AO Points provide for concurrent plotting of Measured value input - present value, present value of output, and AO setpoint. Operator selectable sampling interval to be selectable between 1 second to 20 seconds. Plotting utility to scroll to left as plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.
 - .4 Trend data Module to include display of historical or trend data to OWS screen in X Y plot presentation. Plot utility to display minimum of 6 historical points or 6 trend points concurrently or 1 Control Loop Plot. For display output of real time trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.
 - .5 Provide separate reports for each trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using report module. Ensure trend data is exportable to third party spreadsheet or database applications for PCs.
 - .6 All physical and logical points (unless otherwise approved by owner) to be stored in histories at 15-minute intervals for minimum 1 year. Histories must be viewable using trend data utility.
- .11 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level. Refer also to Section 25 30 01 - EMCS: Building Controllers.
 - .1 Reports to include time, day, month, year, report title, operator's initials.
 - .2 Software to provide capability to:

- .1 Generate and format reports for graphical and numerical display from real time and stored data.
- .2 Print and store reports as selected by operator.
- .3 Select and assign points used in such reports.
- .4 Sort output by area, system, as minimum.
- .3 Periodic/automatic report:
 - .1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit modifying periodic/automatic reporting profile at any time.
 - .2 Reports to include:
 - .1 Power demand and duty cycle summary: see application program for same.
 - .2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.
 - .3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.
 - .4 Summary of run time alarms: include point name, run time to date, alarm limit.
 - .5 Summary of start/stop schedules: include start/stop times and days, point name.
 - .6 Motor status summary.
- .4 Report types:
 - .1 Dynamic reports: system to printout or display of point object data value requested by operator. System to indicate status at time of request, when displayed, updated at operator selected time interval. Provide option for operator selection of report type, by point name, and/or output device. Ensure reports are available for following point value combinations:
 - .2 Points in accessible from this OWS (total connected for this location), multiple "areas".
 - .3 Area (points and systems in Area).
 - .4 Area, system (points in system).
 - .5 System (points by system type).
 - .6 System point (points by system and point object type).
 - .7 Area point (points by system and point object type).
 - .8 Point (points by point object type).
- .5 Summary report: printout or display of point objet data value selected by operator. Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports. Provide option as to report type, point name, output device.
- .6 Include preformatted reports as listed in Event/Alarm Module.

- .12 Graphics Display Module: graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.
- .1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlaid with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.
 - .2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.
 - .3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, VAV), complete mechanical system components (chillers, boilers, pumps), electrical symbols.
 - .4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:
 - .1 Modify portion of graphic picture/schematic background.
 - .2 Delete graphic picture.
 - .3 Call up and cancel display of graphic picture.
 - .4 Define symbols.
 - .5 Position and size symbols.
 - .6 Define background screens.
 - .7 Define connecting lines, curves.
 - .8 Locate, orient, size descriptive text.
 - .9 Define, display colours of elements.
 - .10 Establish co-relation between symbols or text and associated system points or other graphic displays.
 - .5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.
 - .6 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.
 - .7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress. If interface is unable to display several different types of display at same time, provide at minimum 2 OWS's.
 - .8 Utilize graphics package to generate system schematic diagrams as required in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation, and as directed by Consultant. In addition provide

- graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location. For floor graphic include secondary diagram to show TCU-VAV box actuator and, flow sensor. Diagram to be single line schematic of ductwork as well as associated heating coil or radiation valve. Consultant to provide CAD floor layouts. Provide display of TCU - VAV's in table form, include following values as minimum; space temp, setpoint, mode, actual flow, min flow setpoint, max flow setpoint, cooling signal value, and heating signal value. Organize table by rooms and floor groupings.
- .9 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click" to activate selected graphic.
- .10 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain English language.
- .13 Event/Alarm Module: displays in window alarms as received and stored in General Event Log.
- .1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.
- .2 Presentation of alarms to include features identified under applicable report definitions of Report Module paragraph.
- .3 Alarm reports.
- .1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, limit exceeded.
- .2 Analog alarm limit summary: include point name, alarm limits, deviation limits.
- .3 Summary of alarm messages: include associated point name, alarm description.
- .4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.
- .5 EMCS to notify operator of occurrence of alarms originating at field device within following time periods of detection:
- .1 Critical - 5 seconds.
- .2 Cautionary - 10 seconds.
- .3 Maintenance - 10 seconds.
- .6 Display alarm messages in English.
- .7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.
- .8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual

and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgement of one alarm as acknowledgement of other alarms.

- .9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:
 - .1 Controller not responding - where possible delineate between controller and communication line failure.
 - .2 Controller responding - return to normal.
 - .3 Controller communications bad - high error rate or loss of communication.
 - .4 Controller communications normal - return to normal.
- .10 Digital alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.
- .14 Archiving and Restoration Module.
 - .1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.
 - .2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.
 - .3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base, or parts thereof as required.
- .15 CDL Generator and Modifier Module.
 - .1 CDL Generator module to permit generation and modification of CDLs.
 - .2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.
 - .3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.
 - .4 Module to permit testing of code before downloading to building controllers.

2.6 ADDITIONAL UTILITY SOFTWARE

- .1 Supply and install on primary OWS one copy of Microsoft Office 365 Suite including Word, Excel, Outlook, PowerPoint, and OneNote
- .2 Supply and install on primary OWS:

- .1 Include special drivers, fonts, to ensure complete and proper functioning of software packages specified. Deliver system complete with full set of User Manuals.
- .2 Enter soft copy submissions, including "Record" drawings specified in Section 25 05 03 - EMCS: Project Record Documents in OWS.
- .3 Enter soft copy of Architectural, Electrical, Mechanical systems plans and "Record" drawings in OWS. Plans and drawings to be provided by Consultant.

Part 3 Execution

3.1 INSTALLATION REQUIREMENTS

- .1 Provide necessary power as required from local 120 V emergency power branch circuit panels for OWS's and peripheral equipment.
 - .1 Install tamper locks on breakers of circuit panels.
 - .2 Refer to UPS requirements stated under OWS Hardware in PART 2.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for building automation controllers including:
 - .1 Master Control Unit (MCU).
 - .2 Local Control Unit (LCU).
 - .3 Equipment Control Unit (ECU).
 - .4 Terminal Control Unit (TCU).

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 25 05 01 - EMCS: General Requirements.
- .3 Section 25 05 02 - EMCS: Submittals & Review Process
- .4 Section 25 10 01 - EMCS: Local Area Network (LAN)
- .5 Section 25 30 02 - Field Control Devices
- .6 Section 25 90 01 - Site Requirements, Applications and System Sequences of Operation

1.3 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE 2003, Applications Handbook, SI Edition.
- .2 Canadian Standards Association (CSA Group).
 - .1 C22.2 No.205-2012, Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE).
 - .1 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
- .4 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.
 - .1 MD13800-September 2000, Energy Management and Control Systems (EMCS) Design Manual. English: <ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

1.4 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.5 DESCRIPTION

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.
 - .1 Provide sufficient controllers to meet intents and requirements of this section.

- .2 Controller quantity, and point contents to be approved by Consultant at time of preliminary design review.
- .2 Controllers: stand-alone intelligent Control Units.
 - .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
 - .2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.
 - .3 Capable of interfacing with operator interface device.
 - .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
 - .1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
- .3 Interface to include provisions for remote access.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 25 05 02 - EMCS: Submittals & Review Process and Section 01 00 10 - General Requirements
 - .1 Submit product data sheets for each product item proposed for this project.

1.7 MAINTENANCE

- .1 Provide manufacturers recommended maintenance procedures for insertion in O&M manual specified in Section 25 05 02 - EMCS: Submittals & Review Process and Section 01 00 10 - General Requirements

Part 2 Products

2.1 DESIGN REQUIREMENTS

- .1 To include:
 - .1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
 - .2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
 - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
 - .4 Control of systems as described in sequence of operations.
 - .5 Execution of optimization routines as listed in this section.
- .2 Total spare capacity for MCUs and LCUs: at least 25 % of each point type distributed throughout the MCUs and LCUs.
- .3 Field Termination and Interface Devices:
 - .1 To CSA C22.2 No.205.
 - .2 Electronically interface sensors and control devices to processor unit.
 - .3 Include, but not be limited to, following:

- .1 Programmed firmware or logic circuits to meet functional and technical requirements.
- .2 Power supplies for operation of logics devices and associated field equipment.
- .3 Lockable wall cabinet.
- .4 Required communications equipment and wiring (if remote units).
- .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
- .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
- .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
- .4 AI interface equipment to:
 - .1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.
 - .2 Provide for following input signal types and ranges:
 - .1 4 - 20 mA;
 - .2 0 - 10 V DC;
 - .3 100/1000 ohm RTD input;
 - .3 Meet IEEE C37.90.1 surge withstand capability.
 - .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
 - .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .5 AO interface equipment:
 - .1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.
 - .2 Provide for following output signal types and ranges:
 - .1 4 - 20 mA.
 - .2 0 - 10 V DC.
 - .3 Meet IEEE C37.90.1 surge withstand capability.
- .6 DI interface equipment:
 - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
 - .2 Meet IEEE C37.90.1 surge withstand capability.
 - .3 Accept pulsed inputs up to 2 kHz.
- .7 DO interface equipment:
 - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
 - .2 Switch up to 5 amps at 220 V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.

- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged door.
 - .1 Public spaces: Panels to be lockable with same key.
 - .2 Service (non-public) spaces: Panels to have slotted latches.
 - .3 Provide for conduit entrance from top, bottom or sides of panel.
 - .4 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
 - .5 Mounting details as approved by Consultant for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

2.2 MASTER CONTROL UNIT (MCU)

- .1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
 - .1 MCU must support BACnet.
- .3 MCU local I/O capacity as follows:
 - .1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
 - .2 LCUs may be added to support system functions.
- .4 Central Processing Unit (CPU).
 - .1 Processor to consist of minimum 32 bit microprocessor capable of supporting software to meet specified requirements.
 - .2 CPU idle time to be more than 30 % when system configured to maximum input and output with worst case program use.
 - .3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
 - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
 - .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.
 - .4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.
- .5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01 - Site Requirements, Applications and System Sequences of Operation.
 - .1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Consultant.

- .2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.
- .3 Display simultaneously minimum of 16 point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English.
- .4 Functions to include, but not be limited to, following:
 - .1 Start and stop points.
 - .2 Modify setpoints.
 - .3 Modify PID loop parameters.
 - .4 Override PID control.
 - .5 Change time/date.
 - .6 Add/modify/start/stop weekly scheduling.
 - .7 Add/modify setpoint weekly scheduling.
 - .8 Enter temporary override schedules.
 - .9 Define holiday schedules.
 - .10 View analog limits.
 - .11 Enter/modify analog warning limits.
 - .12 Enter/modify analog alarm limits.
 - .13 Enter/modify analog differentials.
- .5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.
- .6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.
- .7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.
- .8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.3 LOCAL CONTROL UNIT (LCU)

- .1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.
- .2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.
- .3 Points integral to one Building System to be resident on only one controller.
- .4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
 - .1 Include minimum 2 interface ports for connection of local computer terminal.
 - .2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.

- .3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
- .4 Include power supplies for operation of LCU and associated field equipment.
- .5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
- .6 Provide conveniently located screw type or spade lug terminals for field wiring.

2.4 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
 - .1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.
- .2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.
- .3 VAV Terminal Controller.
 - .1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.
 - .2 Controller to support point definition; in accordance with Section 25 05 01 - EMCS: General Requirements.
 - .3 Controller to operate independent of network in case of communication failure.
 - .4 Controller to include damper actuator and terminations for input and output sensors and devices.
- .4 Fan Coil Unit Terminal Controller.
 - .1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.
 - .2 Controller to support point definition; in accordance with Section 25 05 01 - EMCS: General Requirements.
 - .3 Controller to operate independent of network in case of communication failure.
 - .4 Controller to include damper actuator and terminations for input and output sensors and devices.

2.5 SOFTWARE

- .1 General.
 - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
 - .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.

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- .3 Include initial programming of Controllers, for entire system.
 - .2 Program and data storage.
 - .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
 - .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.
 - .3 Programming languages.
 - .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
 - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Consultant.
 - .4 Operator Terminal interface.
 - .1 Operating and control functions include:
 - .1 Multi-level password access protection to allow user/manager to limit workstation control.
 - .2 Alarm management: processing and messages.
 - .3 Operator commands.
 - .4 Reports.
 - .5 Displays.
 - .6 Point identification.
 - .5 Pseudo or calculated points.
 - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
 - .2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).
 - .6 Control Description Logic (CDL):
 - .1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
 - .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
 - .3 Perform changes to CDL on-line.
 - .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.

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- .5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
 - .6 MCU to be able to perform following pre-tested control algorithms:
 - .1 Two position control.
 - .2 Proportional Integral and Derivative (PID) control.
 - .7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.
 - .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
 - .9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyse controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyse status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.
 - .7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.
 - .8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.
 - .1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:
 - .1 Time of day scheduling.
 - .2 Calendar based scheduling.
 - .3 Holiday scheduling.
 - .4 Temporary schedule overrides.
 - .5 Optimal start stop.
 - .6 Night setback control.
 - .7 Enthalpy (economizer) switchover.
 - .8 Peak demand limiting.
 - .9 Temperature compensated load rolling.
 - .10 Fan speed/flow rate control.
 - .11 Hot water reset.
 - .12 Chilled water reset.
 - .13 Chiller sequencing.

- .14 Night purge.
- .2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.
- .3 Apply programs to equipment and systems as specified or requested by the Consultant.
- .9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.
 - .1 MCUs to accumulate and store automatically run-time for binary input and output points.
 - .2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.
 - .3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.
 - .4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.
 - .5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWh, litres, tonnes, etc.).
 - .6 Store event totalization records with minimum of 9,999,999 events before reset.
 - .7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.6 LEVELS OF ADDRESS

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.
 - .1 Display analog values digitally to 2 place of decimals with negative sign as required.
 - .2 Update displayed analog values and status when new values received.
 - .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
 - .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.7 POINT NAME SUPPORT

- .1 Controllers (MCU, LCU) to support point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

Part 3 Execution

3.1 LOCATION

- .1 Location of Controllers to be approved by Consultant.

3.2 INSTALLATION

- .1 Install Controllers in secure locking enclosures .
- .2 Provide necessary power from local 120 V branch circuit panel for equipment.

- .3 Install tamper locks on breakers of circuit breaker panel.
- .4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Control devices integral to the Building Energy Monitoring and Control System (EMCS).

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 23 33 15 - Dampers - Operating.
- .3 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
- .4 Section 25 05 01 - EMCS: General Requirements.
- .5 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
- .6 Section 25 05 54 - EMCS: Identification.
- .7 Section 25 90 01 - Site Requirements Applications and Systems Sequences of Operation.
- .8 Section 26 05 00 - Common Work Results for Electrical.

1.3 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI).
 - .1 ANSI C12.7-1993 (R1999), Requirements for Watthour Meter Sockets.
 - .2 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM B148-97 (03), Standard Specification for Aluminum-Bronze Sand Castings.
- .3 National Electrical Manufacturer's Association (NEMA).
 - .1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 Air Movement and Control Association, Inc. (AMCA).
 - .1 AMCA Standard 500-D-98, Laboratory Method of Testing Dampers For Rating.
- .5 CSA Group CSA Group
 - .1 CSA-C22.1 (latest edition), Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

1.4 DEFINITIONS

- .1 Acronyms and Definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 01 00 10 - General Requirements and Section 25 05 02 - EMCS: Submittals and Review Process.
- .2 Manufacturer's Instructions:

- .1 Submit manufacturer's installation instructions for specified equipment and devices.

Part 2 Products

2.1 GENERAL

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant, assembly.
- .3 Operating conditions: 0 - 32 degrees C with 10 - 90 % RH (non-condensing) unless otherwise specified.
- .4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
- .6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
- .8 Devices installed in user occupied space not exceed Noise Criteria (NC) of 25. Noise generated by any device must not be detectable above space ambient conditions.

2.2 TEMPERATURE SENSORS

- .1 General: except for room sensors to be resistance or thermocouple type to following requirements:
 - .1 Thermocouples: limit to temperature range of 200 degrees C and over.
 - .2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
 - .3 Sensing element: hermetically sealed.
 - .4 Stem and tip construction: copper or type 304 stainless steel.
 - .5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.
 - .6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 150 mm as indicated.
- .2 Room temperature sensors and display wall modules.
 - .1 Temperature sensing and display wall module.
 - .1 LCD display to show space temperature and temperature setpoint.
 - .2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
 - .3 Integral thermistor sensing element 10,000 ohm at 24 degrees.
 - .4 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
 - .5 Stability 0.02 degrees C drift per year.
 - .6 Separate mounting base for ease of installation.

- .2 Room temperature sensors:
 - .1 Wall mounting, in slotted type covers having brushed stainless steel finish, with guard as indicated.
 - .2 Element 10-50 mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.
- .3 Duct temperature sensors:
 - .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length as required to locate sensor between 1/4 to midpoint of duct.
 - .2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 1800 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.
- .4 Outdoor air temperature sensors:
 - .1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

2.3 TEMPERATURE TRANSMITTERS

- .1 Requirements:
 - .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.
 - .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.
 - .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
 - .4 Input and output short circuit and open circuit protection.
 - .5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.
 - .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
 - .7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.
 - .8 Integral zero and span adjustments.
 - .9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/50 degrees C.
 - .10 Long term output drift: not to exceed 0.25 % of full scale/6 months.
 - .11 Transmitter ranges: select narrowest range to suit application from following:
 - .1 Minus 50 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.
 - .2 0 to 100 degrees C, plus or minus 0.5 degrees C.
 - .3 0 to 50 degrees C, plus or minus 0.25 degrees C.
 - .4 0 to 25 degrees C, plus or minus 0.1 degrees C.
 - .5 10 to 35 degrees C, plus or minus 0.25 degrees C.

2.4 TEMPERATURE SWITCHES

- .1 Requirements:
 - .1 Operate automatically. Reset automatically, except as follows:
 - .1 Low temperature detection: manual reset.
 - .2 High temperature detection: manual reset.
 - .2 Adjustable setpoint and differential.
 - .3 Accuracy: plus or minus 1 degrees C.
 - .4 Snap action rating: 24V DC as required. Switch to be DPST for hardwire and EMCS connections.
 - .5 Type as follows:
 - .1 Room: for wall mounting on standard electrical box with protective guard as indicated.
 - .2 Duct, general purpose: insertion length = 460 mm.
 - .3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.
 - .4 Low temperature detection: continuous element with 6096 mm insertion length, duct mounting, to detect coldest temperature in any 30 mm length.
 - .5 Strap-on: with helical screw stainless steel clamp.

2.5 HUMIDITY SENSORS

- .1 Room and Duct Requirements:
 - .1 Range: 5 - 90 % RH minimum.
 - .2 Operating temperature range: 0 - 60 degrees C.
 - .3 Absolute accuracy:
 - .1 Duct sensors: plus or minus 2 %.
 - .2 Room sensors: plus or minus 5 %.
 - .4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.
 - .5 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.
 - .6 Room sensors: wall mounted as indicated.
 - .7 Duct mounted sensors: locate so that sensing element is in air flow in duct.
- .2 Outdoor Humidity Requirements:
 - .1 Range: 0 - 100 % RH minimum.
 - .2 Operating temperature range: -40 - 50 degrees C.
 - .3 Absolute accuracy: plus or minus 2 %.
 - .4 Temperature coefficient: plus or minus 0.03%RH/degrees C over 0 to 50 degrees C.
 - .5 Must be unaffected by condensation or 100% saturation.
 - .6 No routine maintenance or calibration is required.

2.6 HUMIDITY TRANSMITTERS

- .1 Requirements:
 - .1 Input signal: from RH sensor.
 - .2 Output signal: 4 - 20 mA onto 500 ohm maximum load.
 - .3 Input and output short circuit and open circuit protection.
 - .4 Output variations: not to exceed 0.2 % of full scale output for supply voltage variations of plus or minus 10 %.
 - .5 Output linearity error: plus or minus 1.0% maximum of full scale output.
 - .6 Integral zero and span adjustment.
 - .7 Temperature effect: plus or minus 1.0 % full scale/6 months.
 - .8 Long term output drift: not to exceed 0.25 % of full scale output/6 months.

2.7 STATIC PRESSURE SENSORS

- .1 Requirements:
 - .1 Multipoint element with self-averaging manifold.
 - .1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).
 - .2 Accuracy: plus or minus 1 % of actual static pressure.

2.8 STATIC PRESSURE TRANSMITTERS

- .1 Requirements:
 - .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
 - .2 Calibrated span: not to exceed 150 % of duct static pressure at maximum flow.
 - .3 Accuracy: 0.4 % of span.
 - .4 Repeatability: within 0.5 % of output.
 - .5 Linearity: within 1.5 % of span.
 - .6 Deadband or hysteresis: 0.1 % of span.
 - .7 External exposed zero and span adjustment.
 - .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.9 PRESSURE TRANSDUCERS

- .1 Requirements:
 - .1 Combined sensor and transmitter measuring pressure.
 - .1 Internal materials: suitable for continuous contact with air, water, as applicable.
 - .2 Output signal: 4 - 20 mA into 500 ohm maximum load.
 - .3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.
 - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.
 - .5 Temperature effects: not to exceed plus or minus 1.5 % full scale/50 degrees C.

- .6 Over-pressure input protection to at least twice rated input pressure.
- .7 Output short circuit and open circuit protection.
- .8 Accuracy: plus or minus 1 % of Full Scale.

2.10 DIFFERENTIAL PRESSURE TRANSMITTERS

- .1 Requirements:
 - .1 Internal materials: suitable for continuous contact with air, water, as applicable.
 - .2 Output signal: 4 - 20 mA into 500 ohm maximum load.
 - .3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.
 - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.
 - .5 Integral zero and span adjustment.
 - .6 Temperature effects: not to exceed plus or minus 1.5 % full scale/50 degrees C.
 - .7 Over-pressure input protection to at least twice rated input pressure.
 - .8 Output short circuit and open circuit protection.
 - .9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.11 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

- .1 Requirements:
 - .1 Internal materials: suitable for continuous contact with air, water, etc., as applicable.
 - .2 Adjustable setpoint and differential.
 - .3 Switch: snap action type, rated at 24 V DC.
 - .4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
 - .5 Accuracy: within 2 % repetitive switching.
 - .6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.
 - .7 Switches on high temperature hot water service: provide pigtail syphon.

2.12 VELOCITY PRESSURE SENSORS (AIRFLOW MEASURING PROBE STATION)

- .1 Multiple averaging pitot/static sensor type, with sensor type, with sensors distributed for equal area averaging of flows.
- .2 Internal pitot/static sensors shall be constructed of aluminum with hard anodized finish, 1/4" barb female instrument connections.
- .3 16 gauge sheet metal housing, flange to duct connections, hexagonal flow straightening vanes incorporated into structure.
- .4 Straight run requirements: 5 dia. or longest duct dimension.
- .5 Sensor quantities:

- .1 Based on duct dimensions:

Duct Diameter / Equivalent Diameter	Quantity
<300	1
300 - 575	2
600 - 875	3
900 - 1500	4
1525 - 2250	5
> 2250	6

- .6 Accuracy: +/- 2% with recommended quantity
- .7 Minimum Airflow: 2 m/s (400 fpm).
- .8 Maximum Airflow: 60 m/s (12000) fpm.
- .9 Acceptable Product: ULTRATECH Industries Ultra Probe AMPS

2.13 VELOCITY PRESSURE TRANSMITTERS

- .1 Requirements:
- .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load over a 0-16 m/s range.
- .2 Calibrated span: not to exceed 125 % of duct velocity pressure at maximum flow.
- .3 Accuracy: 0.4 % of span.
- .4 Repeatability: within 0.1 % of output.
- .5 Linearity: within 0.5 % of span.
- .6 Deadband or hysteresis: 0.1 % of span.
- .7 External exposed zero and span adjustment.
- .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.
- .9 Acceptable Products: Greystone Energy Systems, ACI, BAPI, Johnsons Control

2.14 FLOW SWITCHES

- .1 Paddle type
- .1 Acceptable only where explicitly noted on drawings.
- .2 Flow switch for low flow water applications, SPDT, snap acting, pipe size as indicated, CSA Enclosure, rated at 16 A at 120 V, 25mmØ NPT connection.
- .3 Maximum liquid temperature 121 degrees C. Maximum liquid gauge pressure of 1034 kPa ambient temperature range 0 degrees C to 82 degrees C.
- .4 Acceptable material: ITT McDonnell Miller FS4-3.
- .2 Thermal dispersion type, no indication
- .1 Acceptable for all locations unless noted otherwise.
- .2 Sensor consisting of two RTD elements, one being a reference and the second with a heating element to increase its temperature above the process fluid temperature. Integral electronics detect the temperature difference between the two RTD elements and provide flow indication.

- .1 Operating principle based on temperature difference being the greatest when fluid is stationary and decreasing as flow rates increase which will cool the heated element.
- .3 Setpoint adjustable to switch at desired temperature difference (flow rate setpoint).
- .4 Power: to suit application, 12VDC, 120V AC, or 24 VDC/AC
- .5 Acceptable material: Ameritrol Inc FM series
- .3 Thermal dispersion type, with indication
 - .1 Sensor consisting of two RTD elements, one being a reference and the second with a heating element to increase its temperature above the process fluid temperature. Integral electronics detect the temperature difference between the two RTD elements and provide flow indication.
 - .1 Operating principle based on temperature difference being the greatest when fluid is stationary and decreasing as flow rates increase which will cool the heated element.
 - .2 Setpoint adjustable to switch at desired temperature difference (flow rate setpoint).
 - .3 Switch to have LED lights for flow and integral alarm/fault indication
 - .4 Power: to suit application, 120 to 240 VAC or 19.2 to 28.8 VDC
 - .5 Acceptable material: Magnetrol Thermo-Tel TD2 (spherical tip, 19mmØ NPT connection)

2.15 ELECTROMECHANICAL RELAYS

- .1 Requirements:
 - .1 Double voltage, DPDT, plug-in type with termination base.
 - .2 Coils: rated for 120V AC. Other voltage: provide transformer.
 - .3 Contacts: rated at 5 amps at 120 V AC.
 - .4 Relay to have visual status indication

2.16 SOLID STATE RELAYS

- .1 General:
 - .1 Relays to be socket or rail mounted.
 - .2 Relays to have LED Indicator
 - .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
 - .4 Operating temperature range to be -20 degrees C to 70 degrees C.
 - .5 Relays to be CSA Certified.
 - .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
 - .7 Operational frequency range, 45 to 65 HZ.
- .2 Input:
 - .1 Control voltage, 3 to 32 VDC.
 - .2 Drop out voltage, 1.2 VDC.

- .3 Maximum input current to match AO (Analog Output) board.
- .3 Output.
 - .1 AC or DC Output Model to suit application.

2.17 CURRENT TRANSDUCERS

- .1 Requirements:
- .2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:
 - .1 4-20 mA DC.
 - .2 0-10 volts DC.
- .3 Frequency insensitive from 10 - 80 hz.
- .4 Accuracy to 0.5% full scale.
- .5 Zero and span adjustments. Field adjustable range to suit motor applications.
- .6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.18 CURRENT SENSING RELAYS

- .1 Requirements:
 - .1 Suitable to detect belt loss or motor failure.
 - .2 Trip point adjustment, output status LED.
 - .3 Split core for easy mounting.
 - .4 Induced sensor power.
 - .5 Relay contacts: capable of handling 0.5 amps at 30 VAC/DC. Output to be NO solid state.
 - .6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
 - .7 Adjustable latch level.

2.19 CONTROL VALVES

- .1 Body: ball style, characterized disc as required for CV range.
 - .1 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
 - .2 Normally open unless otherwise indicated.
 - .3 Two or Three port, as indicated.
 - .4 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
 - .5 Packing easily replaceable.
 - .6 Stem, stainless steel.
 - .7 Plug and seat, stainless steel, brass, bronze.
 - .8 Disc, replaceable, material to suit application.
 - .9 NPS 2 and under:
 - .1 Screwed National Pipe Thread (NPT) tapered female connections.
 - .2 Valves to ANSI Class 250, valves to bear ANSI mark.

- .3 Rangeability 50:1 minimum.
- .10 NPS 2½ and larger:
 - .1 Flanged connections.
 - .2 Valves to ANSI Class 150 or 250 as indicated, valves to bear ANSI mark.
 - .3 Rangeability 100:1 minimum.

2.20 ELECTRONIC/ELECTRIC VALVE ACTUATORS

- .1 Requirements:
 - .1 Construction: steel, cast iron, aluminum.
 - .2 Control signal:
 - .1 Modulating: 4-20 mA DC or 0-10V DC.
 - .2 Non-modulating (open/close): as required for open/close control.
 - .3 Positioning time: to suit application. 30 sec maximum.
 - .4 Fail to normal position as indicated.
 - .5 Scale or dial indication of actual control valve position.
 - .6 Size actuator to meet requirements and performance of control valve specifications.
 - .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.
 - .8 Minimum shut-off pressure: refer to control valve schedule.

2.21 CONTROL DAMPERS

- .1 Refer to Section 23 33 15 - Dampers - Operating

2.22 ELECTRONIC CONTROL DAMPER ACTUATORS

- .1 Requirements:
 - .1 Direct mount proportional type as indicated.
 - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
 - .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
 - .4 Power requirements: 5 VA maximum at 24 V AC.
 - .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
 - .6 For VAV box applications floating control type actuators may be used.
 - .7 Damper actuator to drive damper from full open to full closed in less than 90 seconds.

2.23 THERMAL ENERGY METERS

- .1 Thermal Energy (kWh/BTU) Measurement System including micro-processor based kWh/BTU meter, flowmeter, matched set of temperature sensors and mechanical installation hardware and cabling required for a complete system installation. kWh/BTU measurement system shall be configured for the specific application prior to delivery.

- .2 End connections:
 - .1 NPS 2 and under: screwed.
 - .2 NPS 2-1/2 and over: flanged.
- .3 Pressure rating: minimum 1.5 times the maximum pressure of the piping where the meter will be installed.
- .4 Warranty: Each meter shall be covered by the manufacturer's three-year warranty.
- .5 Listings and Certifications:
 - .1 Meter shall have FCC: Part 15, Subpart B
 - .2 Meter shall have CE approval and be UL listed
 - .3 Meters selected with BACnet shall have BTL Certification to ASHRAE 135:2009
- .6 Calibration and Configuration: Each thermal energy (kWh/BTU) metering system shall be factory programmed for the specific application and each metering system component, including temperature sensors and flow meter, shall receive a certificate of calibration, directly traceable to N.I.S.T.
- .7 Transmitter and Display:
 - .1 Enclosure: NEMA 12K enclosure minimum, designed for wall or DIN rail mounting, non-metallic enclosure materials of construction must meet UL 94 V-0 flammability requirements and be suitable for use in plenum spaces, rated for -25 to 60 degrees C ambient temperatures.
 - .2 Operator interface shall consist of four push-buttons and graphical interface. Display shall visually indicate total fluid volume in liters, instantaneous flow rate in liters per second, supply temperature and return temperature in degrees C, thermal energy flow rate in watts, and thermal-energy flow total in kilowatts per hour.
 - .3 Electrical input: 20-28 Vac/dc
 - .4 Output signal: RS485 serial network protocol, native BACnet MS/TP or MODBUS RTU, three (3) programmable pulse outputs and one (1) analog output signal.
 - .5 Meter shall have the capability to receive and totalize three (3) auxiliary input pulses which can be viewed locally and communicated over the RS485 network.
 - .6 kWh/BTU calculator: Computation error less than or equal to 0.09% at 30 degree F delta T.
 - .7 Trend logging interval: user adjustable from 30s to 1 hour, set initially for every 5 minutes.
- .8 Temperature sensors:
 - .1 Current (mA) based sensors:
 - .1 Provide a matched pair of loop powered, current (mA) based temperature sensors, wet calibrated over the intended application range against NIST traceable standards.
 - .2 Current (mA) signal shall be unaffected by wire length.
 - .3 Differential temperature measurement uncertainty within calibrated range shall be less than or equal to +/- 0.15 degrees F.
 - .2 Resistance Temperature Device (RTD):

- .1 Provide a matched pair of 1000 Ohm platinum RTDs, wet calibrated to a differential measurement uncertainty of +/- 0.18 degree F over the stated range.
- .2 RTD's must meet EN1434/C900 accuracy requirements for 3K sensors.
- .3 Temperature range to suit piping system sensors install in with min/max temperatures exceeding system min/max temperatures by a minimum of 25%.
- .9 Liquid flow meter
 - .1 Insertion turbine flowmeter complete with NIST traceable, wet calibrated flow-measuring element, integral transmitter, installation valves, depth gage and calibration certificate.
 - .1 Flowmeter shall be wet tappable, allowing insertion and removal from the flow stream without system shutdown.
 - .2 Sensing Technology: Axial Turbine flow-measuring element; either single or dual turbine based on application requirements.
 - .3 Design: Axial insertion turbine design with electronic impedance-based sensing circuit; dual insertion turbine shall incorporate two contra rotating turbines and an averaging circuit to reduce measurement errors due to flow distortions, such as swirl, when installed in piping configurations with reduced straight run.
 - .1 Single axial turbine sensing element acceptable for line sizes NPS 2 and smaller
 - .2 Dual axial turbine sensing element acceptable for line sizes NPT 2-1/2 and larger.
 - .4 Plated brass or 316L stainless steel with attached tag indicating calibration information.
 - .2 Accuracy: Flowmeter shall provide calibrated outputs, directly from the integral transmitter, throughout the operating range with the accuracy stated as follows:
 - .1 Plus or minus 0.5% of rate at calibrated velocity
 - .2 Plus or minus 1.0% of rate from 3.0 to 30.0 ft/sec velocity (10:1 turndown).
 - .3 Plus or minus 2.0% of rate from 0.4 to 20 ft/sec velocity (50:1 turndown).
 - .3 Repeatability: plus or minus 0.2 %.
 - .4 Warranty: Each flowmeter shall be covered by the manufacturer's one year no fault and three year warranty.
- .10 Acceptable Material: Onicon System 20 with F-1000 flow meter

2.24 WATTHOUR METERS AND CURRENT TRANSFORMERS

- .1 Requirements:
 - .1 Include three phases, test and terminal blocks for watthour metre connections and connections for monitoring of current. Provide two transformers for 600 V 3 wire systems for watthour meter use. Accuracy: plus or minus 0.25 % of full scale. For chiller applications: to have instantaneous indicator with analog or digital display.
 - .2 Watthour metre sockets: to ANSI C12.7.

- .3 Potential and current transformers: to ANSI/IEEE C57.13.
- .4 Potential transformers: provide two primary fuses.
- .5 Demand meters: configure to measure demand at 15 minute intervals.

2.25 SURFACE WATER DETECTORS

- .1 Requirements:
 - .1 Provide alarm on presence of water on floor.
 - .2 Expendable cartridge sensor.
 - .3 Internal waterproof switch.
 - .4 One set of dry contacts 2 amps at 24 V.
 - .5 Unaffected by moisture in air.
 - .6 Self-powered.

2.26 DUCTED FUME HOOD CONTROLLER AND FACE VELOCITY MONITOR/ALARM DEVICE

- .1 General:
 - .1 The Fume Hood Controller is an ultra-sensitive instrument used to monitor and/or control the fume hood face velocity, and is capable of measuring and displaying face velocities from zero to 200 ft/min (1.016 m/sec) with an accuracy of ± 2 ft/min.
 - .2 Control and monitor the airflow and exhaust of fume hoods to protect scientists from toxic vapors and dusts during experiments.
 - .3 The controller uses a closed-loop system to regulate air entering and exiting the fume hood utilizing a sidewall sensor and sash position sensor to monitor the airflow with a high degree of reliability.
 - .4 Incorporate a user-friendly touchscreen with intuitive menus. The color-coded halo light allows users to easily monitor any fume hood from across the lab. The lighting instantly updates as conditions change, and immediately alerts users of unsafe conditions with both visual and audible alarms. The home screen simultaneously displays the current fume hood status, sash height, face velocity, air flow rate, time, and date.
- .2 Key features:
 - .1 Built-in Setup Wizard for fast and easy setup and configuration
 - .2 Three selectable control modes available: sidewall only, sash position only, sash with sidewall for closed-loop performance
 - .3 Comprehensive closed-loop sash control with sidewall velocity sensing
 - .4 Full-color touchscreen display with programmable display options and adjustable backlight
 - .5 Intuitive user interface simplifies setup and configuration of unit
 - .6 Safety Halo™ provides full 180° visibility from anywhere in laboratory
 - .7 Audible and visual alarms with configurable delays
 - .8 Auxiliary universal analog inputs for use with optional sensors
 - .9 Four independent proportional-integral-derivative (PID) control loops for controlling damper actuators, speed drives, humidifiers, etc.

- .10 Digital input used to monitor an optional fume hood sash switch, zone presence sensor or emergency purge switch.
 - .11 Relay outputs used for transmitting alarm condition to remote location
 - .12 Multi-trigger emergency purge option
 - .13 Multi-level password protection of touchscreen user interface
 - .14 Field calibration of both sidewall velocity sensor and optional sash position sensor
 - .15 Multi-protocol native (BACnet, Metasys N2) for easy integration with any building management system (BMS)
 - .16 Manual override of analog and relay outputs assist with test and balance procedures
 - .17 Comprehensive real time view diagnostics tool built into each unit
 - .18 Easy-to-install backplane/backplate assembly facilitates permanent termination of all wiring
- .3 Feature descriptions:
- .1 Bold, modern graphics with Safety Halo status indicator. This feature significantly enhances the alarm status indication of the device by providing full 180° visibility of the color-coded hood statuses.
 - .2 Equipped with a 3.2" diagonal full-color touchscreen display in portrait orientation (240 x 320). The password-protected menu tree is very intuitive and simplifies the setup and configuration of the unit. The menus incorporate touch-based interfaces such as sliders, radio buttons, and dialog popups to facilitate the ease-of-use of the device. The display implements bright graphical color changes to indicate the three different alarm status indication of the monitored fume hood. These graphical backgrounds indicate "Normal" when the face velocity is within defined limits, "Warning" when the face velocity is approaching an out-of-limits condition, and "Alarm" when the face velocity is outside the defined acceptable and safe limits. The face velocity ranges for these conditions are easily configured by the user for the specific installation, either directly from the touchscreen display or over the network from the BMS.
 - .3 The user may set up multiple multi-level passwords to prevent unauthorized or casual access to the devices configuration settings. Up to ten passwords of up to eight digits may be programmed, with each having one of four associated access levels. Administrators and facility management personnel may have unrestricted access, while general staff may be assigned restricted access passwords which limit the functionality of the user menus
 - .4 Alarm conditions may be defined by the user, in terms of desired face velocity settings for the fume hood being monitored. When an alarm condition occurs, it may be annunciated in four user-definable ways: 1) on the display, 2) with an audible alarm, 3) transmitted via contacts to a remote monitoring location and 4) over the BMS network. The alarm will automatically reset when the unit has sensed that the fume hood face velocity has returned to proper limits. The operator may easily mute the audible alarm by tapping the Alarm Audible button at the bottom of the touchscreen display.
 - .5 The universal analog outputs may be configured for either current loop operation or for voltage operation. Each analog output may be configured for

proportional operation to provide a linear signal to the BMS, or for PID control operation for closed-loop feedback control of damper actuators, variable frequency (speed) drives, humidifiers, or other analog-controlled devices. Each universal analog output may be field-configured for the required application using onboard configuration dials on the controller module. Each analog output may also be temporarily overridden using the built-in diagnostic tools for troubleshooting during the installation and commissioning phase

- .6 The relay outputs may be configured for either direct-acting or reverse-acting operation, and may have a programmable delay associated to meet the specific needs of the required application. The device shall be capable of triggering a relay output for the purpose of activating an optional automatic sash closer device, thereby keeping an unattended fume hood with an open sash safe for occupants of the lab. Each relay output may also be temporarily overridden using the built-in diagnostic tools for troubleshooting during the installation and commissioning phase.
- .7 The relay outputs may be used for remote alarm annunciation or pilot control functions. The operation of each output may be configured by the user to define the exact fume hood face velocity values above and below which the output will operate. Delay times before activation may be specified to minimize nuisance alarms. Each relay output may be configured for either direct action or reverse action. The configuration of each relay output is field selectable through the password-protected user menus.
- .8 The digital inputs may be used for monitoring sash switches, emergency purge switches, flow switches, occupancy sensors, or other devices with binary outputs. The configuration and operation of each input may be configured by the user to define the effect of a change in its state. Each digital input may have a programmable delay duration associated with it. Each digital input may be configured for either normally-closed or normally-open operation. Digital inputs may also be globally configured to be active-high or active-low triggered. The global configuration of the digital inputs is field selectable through the use of a configuration switch on the controller unit.
- .9 Fume hood operating mode selection of occupied, unoccupied, or decommissioned may be protected using limited access passwords, thereby eliminating the need for keylock switches and keys. However, an optional keylock switch may be used to further control access to change in operating modes. The device provides native support for multiple networking protocols, including BACnet MS/TP and Metasys N2 Open. With multi-protocol native support, the device is able to communicate fume hood status information to the building automation system. The configuration of the desired protocol is field selectable through the use of miniature dials on the controller unit
- .10 The HMS-1655 provides a unique set of built-in diagnostics tools for the troubleshooting process during the installation and commissioning phase. The built-in diagnostics tools include manual override capabilities for both analog outputs and relay outputs, and a comprehensive real-time view capability that allows the real-time values and states of each analog and digital input and output to be displayed conveniently. These are extremely useful tools used to facilitate the verification and certification processes conducted by typical test and balance personnel during the commissioning of the system. There are also options for storing configuration settings and for restoring those settings, as well as performing a complete restoration of the factory default configuration settings.

- .4 Technical requirements
 - .1 Face velocity range: 0 fpm - 200 fpm
 - .2 Alarm range: 0 fpm - 200 fpm
 - .3 Display range: 0 fpm - 200 fpm
 - .4 Accuracy: ± 2 fpm at 60 fpm - 140 fpm, ± 5 fpm outside this range
 - .5 Sidewall sensor: Digital ultra-low differential pressure
 - .6 Sash position sensor: Vertical height up to 50 in.
 - .7 Control resolution: ± 2 fpm
 - .8 Control capability: Sash position with sidewall sensing feedback for closed-loop control
 - .9 Analog inputs: 4 universal (4 mA - 20 mA, 0 VDC - 5 VDC, 0 VDC - 10 VDC), 2 thermistor inputs (NTC Type 2 or 3, 10 kohm at 25°C)
 - .10 Analog outputs: 4 universal (4 mA - 20 mA, 0 VDC - 5 VDC, 0 VDC - 10 VDC)
 - .11 Digital inputs: 4 active-high or active-low (0 VDC - 5 VDC or 0 VDC - 24 VDC or 0 VAC - 24 VAC)
 - .12 Relay outputs: 3 sets of N.O. contacts (1 A at 24 VDC)
 - .13 Communication protocols: BACnet MS/TP, Metasys N2 open
 - .14 Operating temperature 0°C to 51.6°C operating
 - .15 Operating humidity 10% - 95% relative humidity, non-condensing
 - .16 Exterior dimensions, plastic surface mount housing: 3 in. W x 5 in. H x 1.13 in. D
 - .17 Mounting styles: Surface (no cutout required)
 - .18 Power requirements: 24 VAC $\pm 10\%$, 30 VA
 - .19 Password protection: Up to 10 user passwords with 4 access levels
 - .20 Memory: Non-volatile
 - .21 Display: 18 bit (262 K) color thin-film-transistor (TFT), 3.2 in. diagonal, resistive touchscreen, 2500 cd/m²
 - .22 Alarm indication 360° Safety Halo visual indication, industry standard status colors with action icons
 - .23 Alarm silence: Touchscreen, auto-reset
 - .24 Warranty: Three year parts warranty from date of manufacture
 - .25 Compliance: cSGSus Listed for US and Canada in contract number 800130, FCC Part 15, ICES-003, BTL Listing
- .5 Acceptable material:
 - .1 Johnson Controls HMS1655-S

2.27 PANELS

- .1 Free-standing or wall mounted enamelled steel cabinets with hinged and key-locked front door.
- .2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Consultant without adding additional cabinets.

- .3 Public spaces: Panels to be lockable with same key.
- .4 Service (non-public) spaces: Panels to have slotted latches.

2.28 WIRING

- .1 In accordance with Division 26.
- .2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .3 Wiring must be continuous without joints.

Part 3 Execution

3.1 INSTALLATION

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00 - Fire stopping. Maintain the fire-resistance rating integrity of the fire separation.
- .6 Electrical:
 - .1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .2 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
 - .3 Install communication wiring in conduit.
 - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
 - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
 - .3 Maximum conduit fill not to exceed 40%.
 - .4 Design drawings do not show conduit layout.
 - .4 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Consultant to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

3.2 PANELS

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

- .3 Identify wiring and conduit clearly.

3.3 TEMPERATURE AND HUMIDITY SENSORS

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
 - .1 Protect from solar radiation and wind effects by non-corroding shields.
 - .2 Install in NEMA 4 enclosures.
- .4 Duct installations:
 - .1 Do not mount in dead air space.
 - .2 Locate within sensor vibration and velocity limits.
 - .3 Securely mount extended surface sensor used to sense average temperature.
 - .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
 - .5 Support sensor element separately from coils, filter racks.
- .5 Averaging duct type temperature sensors.
 - .1 Install averaging element horizontally across the ductwork starting 305 mm from top of ductwork. Each additional horizontal run to be no more than 305 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
 - .2 Wire multiple sensors in series for low temperature protection applications.
 - .3 Wire multiple sensors separately for temperature measurement.
 - .4 Use software averaging algorithm to derive overall average for control purposes.
- .6 Thermowells: install for piping installations.
 - .1 Locate well in elbow where pipe diameter is less than well insertion length.
 - .2 Thermowell to restrict flow by less than 30%.
 - .3 Use thermal conducting paste inside wells.

3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

- .1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.
 - .1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

3.5 AIR FLOW MEASURING STATIONS

- .1 Protect air flow measuring assembly until cleaning of ducts is completed.

3.6 THERMAL ENERGY METERS

- .1 Install meters and transmitters/displays in accessible locations in piping systems adjacent to machines and equipment to allow service and maintenance.

- .2 Install flowmeter elements with at least the minimum straight lengths of pipe, upstream and downstream from meter, required to produce the published flowmeter accuracy according to manufacturer's written instructions.
- .3 The contractor shall be responsible for connecting flowmeter transmitters to flow metering elements as required.
- .4 After installation, commission all meters according to manufacturer's written instructions.
- .5 Adjust faces of meters and transmitters/displays to proper angle for best visibility. Refer to manufacturers written instructions.
- .6 Installation of Signal Transmission Cable
 - .1 Ground shielding at one point only.
 - .2 Protect against RF interference.
 - .3 Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.
- .7 Meters shall be configured to show metric units as follows:
 - .1 Energy: kWh
 - .2 Energy rate: kW
 - .3 Temperature: Celsius
 - .4 Flow rate: L/s
 - .5 Volume: L

3.7 DUCTED FUME HOOD CONTROLLER AND FACE VELOCITY MONITOR/ALARM DEVICE

- .1 Install in accordance with manufacturer's requirements and recommendations.
- .2 Coordinate control wiring and controller setups with ducted fume hood exhaust fan system controller. Refer to Section 23 34 00 - HVAC Fans for fume hood fan and controller requirements.
- .3 After installation, verify operation of controller and controlled fume hood exhaust fan at varying fume hood sash positions and confirm the fume hood face velocity if maintained at 60 FPM.

3.8 IDENTIFICATION

- .1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

3.9 TESTING AND COMMISSIONING

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 At minimum detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.
 - .1 Control Description Logic (CDL) for each system.
 - .2 System Diagrams consisting of the following: EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS), System flow diagram for each system, and points of interface with MCC starters, individual starters, or relays.

1.2 RELATED REQUIREMENTS

- .1 Section 01 00 10 - General Requirements
- .2 Section 01 91 13 - General Commissioning Requirements
- .3 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
- .4 Section 25 05 01 - EMCS: General Requirements.
- .5 Section 25 05 02 - EMCS: Submittals and Review Process.
- .6 Section 25 05 03 - EMCS: Project Record Documents
- .7 Section 25 30 01 - EMCS: Building Controllers
- .8 Section 26 05 00 - Common Work Results for Electrical.

1.3 REFERENCE STANDARDS

- .1 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.
 - .1 MD13800-September 2000, Energy Management and Control Systems (EMCS) Design Manual. English: <ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

1.4 SEQUENCING

- .1 Present sequencing of operations for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.

1.5 ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

- .1 For additional acronyms, abbreviations, and definitions used in these specifications, refer to:
 - .1 Section 22 05 00 - Common Work Results for Plumbing
 - .2 Section 23 05 00 - Common Work Results for Mechanical
 - .3 Section 26 05 00 Common Work Results for Electrical
- .2 The following is a list of acronyms and abbreviations used in these specifications.

SOP	Sequence of Operation
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1.6 HVAC SYSTEMS OVERALL OBJECTIVES

- .1 Program the system to meet the following objectives:
 - .1 Temperature:
 - .1 Control the temperature in each occupied space.
 - .2 Ventilation:
 - .1 Control the system's outdoor air intake and distribution to each space to achieve the specified outdoor air volumes under all operating conditions.
 - .2 Maintain the required pressure relationships between the spaces.
 - .3 Maintain a constant negative pressurization of the lab spaces to ensure no mitigation of fumes, odors, and other air borne contaminants to other spaces.
 - .3 Energy:
 - .1 Provide no more heating or cooling than is essential.
 - .2 Utilize heat recovered by the FGE system from the Energy Center boilers whenever possible, to maintain the space temperature set point.
 - .1 The thermal storage tanks are to be the secondary source of heat to supplement the FGE system.
 - .2 The electric boilers are to be used as a backup source of heat when:
 - .1 The FGE system is not operation (i.e. offline due to issue with system)
 - .2 The thermal storage tanks have been exhausted of their usable heat energy and the FGE system cannot meet the demand alone.
 - .3 Recover heat from the chilled water system and supply to the heating water system via the heat recovery heat pump when there is a simultaneous demand for heating and cooling.
 - .4 Incorporate setback temperatures during unoccupied periods.
 - .5 Operate equipment at high efficiency under all load conditions.

1.7 HOURS OF OPERATION

- .1 Facility hours of operation to be confirmed with the Owner.
- .2 The initial general hours of operation for the facility will be:
 - .1 0700 to 2000 Mondays to Fridays.
 - .2 0800 to 1800 Saturday
 - .3 0800 to 1800 Sunday

1.8 SEQUENCING

- .1 The EMCS contractor shall use their expertise to develop specific programming based on Sequences of Operation contained in this section and shall allow for optimal start-stop, unoccupied set back, morning warm-up mode, and exhaust purge modes to maximize

energy efficiency of the HVAC system while operating the HVAC system as per the guidelines described.

Part 2 Products - Not Used

Part 3 Execution

3.1 SOP - GENERAL

- .1 Unless explicitly noted otherwise, all setpoints and time delays to be user adjustable.
- .2 Unless explicitly noted otherwise, EMCS system (including but not limited to OWS, building controllers, and field control devices) to operate on standby power.
- .3 Data retention:
 - .1 A copy of all trend and metering data must be retained on the local EMCS system for the time periods below.
 - .2 Data older than 24 months may be retained in an external database, however, must be readily accessible and easily manipulated in conjunction with data 24 months or less.
 - .3 Trend log data must be retained for a minimum of 10 years.
 - .4 All metering data must be retained for a minimum of 10 years.

3.2 SOP - FIRE WATER

- .1 Fire water pump and jockey pump to operate via packaged controller supplied with the pump package and as per building fire alarm system as detailed in Division 28.

3.3 SOP - FIRE ALARM SYSTEM MONITORING

- .1 The Fire Alarm system shall be monitored by the EMCS via a dry contact output in the Fire Alarm Panel to indicate an Alarm condition in the Fire Alarm system.
- .2 System to operate in standby power operation and be monitored by the EMCS.

3.4 SOP - SECURITY SYSTEM MONITORING & ALARM INDICATION

- .1 EMCS contractor to provide a dedicated I/O module in SB1057 - Network & Security Room for interfacing with the Building Security System.
- .2 The Security system shall be monitored by the EMCS via a dry contact to indicate building occupied/unoccupied status.
- .3 The EMCS shall notify the building operator of trouble indication via email messages and/or text messages, method and items to notify for selectable by user.
- .4 The EMCS shall notify the building operator of alarms via email messages and/or text messages, method and items to notify for selectable by user.
- .5 The EMCS shall alarm to the building Security system via dry contacts for the following critical alarms:
 - .1 Building low temperature
 - .2 Building high temperature
 - .3 FGE system failure
 - .1 Economizer pump failure

- .2 Economizer loop no flow (BTU meter)
- .3 Heating water low pressure (leak)
- .4 Thermal storage tank leak
- .5 Lab exhaust VAV box failure
- .6 Ducted fume hood exhaust fan failure
- .7 Water room (fire pump) cooling fan failure
- .6 System to operate in standby power operation and be monitored by the EMCS.

3.5 SOP - BUILDING OCCUPANCY STATUS

- .1 In addition to the monitoring of the building security status for occupancy (clause 3.4.2 above), building to have an occupancy schedule.
- .2 Occupancy schedule (to be confirmed with Owner):

Day	Occupied Start	Occupied End
Monday	7 am	10 pm
Tuesday	7 am	10 pm
Wednesday	7 am	10 pm
Thursday	7 am	10 pm
Friday	7 am	10 pm
Saturday	10 am	6 pm
Sunday	10 am	6 pm

- .3 Occupancy schedule to be fully adjustable and allow for multiple occupied / unoccupied periods in a given day.
- .4 Occupancy schedule to allow for special occasions such as holidays.

3.6 SOP - METER MONITORING

- .1 The consumption of all domestic water meters shall be monitored. See system schematics.
- .2 The consumption of all thermal energy meters (DHW, HW, GL, CHW) shall be monitored. See system schematics.
 - .1 All thermal energy metering data must be recorded and displayed in metric units.
 - .2 The energy meters are to monitor and record flow rate (L/s) and supply and return water temperature (degrees C). The energy meters are to provide a calculated energy (kW) input/output and consumption rate (kWh) to/from the heating/cooling piping systems at the various stations.
- .3 The consumption of all electric meters shall be monitored. See system schematics.
- .4 Monitor as needed to meet Zero Carbon and Net-Zero Energy requirements.
 - .1 The metering interval for measured and calculated values must be 5 minutes or less.
- .5 System to operate in standby power operation and be monitored by the EMCS.

3.7 SOP - BUILDING LOW AND HIGH TEMPERATURE ALARMS

- .1 EMCS to monitor all space temperature sensors and thermostats in the building for space low and high temperatures.

- .2 On temperature below low temperature setpoint, EMCS to alarm low temperature to Security System and provide alarm callout to operator.
 - .1 Initial building low temperature setpoint = 10°C
- .3 On temperature above high temperature setpoint, EMCS to alarm high temperature to Security System and provide alarm callout to operator.
 - .1 Initial building high temperature setpoint = 28°C
- .4 System to operate in standby power operation and be monitored by the EMCS.

3.8 SOP - OUTSIDE AIR TEMPERATURE

- .1 Provide outside air temperature sensors as follows:
 - .1 North side of SB1028 - Mechanical Room at 3600mm above grade
 - .2 East wall of SB1028 - Mechanical Room on roof near NW corner at 900mm above the roof. Place sensor as near to roof edge as practical to limit interference from nearby E/A louvers and chillers.
 - .3 North side of SB1002 - Lecture Hall near NE corner of building at 3600mm above grade
- .2 OAT calculated values will be used for all control sequences and shall be a software data value.
 - .1 This calculated value will be determined from the various outdoor air temperature sensors.
 - .2 A calculation shall be provided to indicate continuously the lowest, average and highest, and the individual processes shall use the respective calculated temperature.
 - .3 Any individual OAT sensor that is determined to be in error will not be used in determination of the calculated value and will be flagged as an alarm situation.
 - .4 The calculation shall operate at least every 5 minutes and update the values accordingly.
- .3 Allow for separate data points and respective values for each calculated value to be entered by the operator to bias each calculated values. This will be used to assist in altering the programs when there are abnormal weather conditions affecting the sensors.
- .4 System to operate in standby power operation and be monitored by the EMCS.

3.9 SOP - DOMESTIC WATER SYSTEMS

- .1 Domestic water pressure boosting system: P-W-3/4/5
 - .1 Packaged controller to provide lead/lag/standby control of pumps and variable speed control to maintain domestic water supply pressure setpoint.
 - .2 Packaged controller to be supplied with communication module for BACnet communication with EMCS.
 - .3 On failure of a pump or a trouble signal, controller to alarm to EMCS.
- .2 Domestic Hot Water Heater, with recirculation:
 - .1 Applicable DHW systems: DHWH-1/2 and P-W-6/7
 - .2 Tank mounted aquastat to cycle DHWH element(s) to maintain 60°C setpoint.
 - .3 The DHWR Pumps to operate lead/standby.

- .1 Alternate the lead pump on total run time duty cycle alternating after 168hrs operation. If the lead pump fails auto-change to the standby pump.
- .4 The lead pump DHWR pump to operate:
 - .1 If the DHW return temperature measured at the pump falls below the DHWR setpoint for more than 5 minutes
 - .1 Initial setpoint = 55°C
 - .2 A minimum of 5 minutes per hour
 - .5 Once enabled, pump minimum run time to be 5 minutes to prevent short cycling.
- .6 The following conditions for the DHW system will cause a trouble signal:
 - .1 DHW supply temperature over 65°C for 2 minutes.
 - .2 DHW return temperature below 55°C for 10 minutes.
 - .3 The DHWR pumps operating outside their normal parameters for two minutes.
- .3 Domestic Hot Water Heater, no recirculation
 - .1 Applicable DHWH systems: DHWH-3 to DHWH-7
 - .2 Tank mounted aquastat to cycle DHWT element(s) to maintain 60°C setpoint.
 - .3 Where the DHWH serves washroom lavatory faucets:
 - .1 Lavatory faucets are to have their integral purge mode set for every 12 hrs. Where multiple faucets, purge mode times to be staggered by 3-6 hours.
- .4 Systems to operate in standby power operation and be monitored by the EMCS.

3.10 SOP - REVERSE OSMOSIS SYSTEM

- .1 RO system to operate on package controls supplied with system.
- .2 RO system controller to indicate alarm to EMCS system via dry contact to indicate issue requiring attention of maintainer.
- .3 System DOES NOT operate in standby power operation.

3.11 SOP - FLUE GAS ECONOMIZER

- .1 Description:
 - .1 The Flue Gas Economizer system is composed of the Flue gas economizer (HEX-FGE), VFD forced draft fan (F-FGE), boiler chimney dampers and temperature sensors, flue gas economizer temperature sensors, energy meter (liquid side flow meter and temperature sensors), and a PLC controller.
 - .2 The emergency heating system is composed of a heat exchanger (HEX-1), manual normally closed isolation valves and normally open bypass valve, modulating 2-way control valve (on Energy Center side of HEX), and a modulating temperature controller with supply and return temperature sensors.
- .2 General:
 - .1 A PLC controller provided as part of the Flue Gas Economizer system will provide control of the economizer system (temperature sensing, damper control, fan speed control, water side bypass control valve, energy meter).

- .1 The PLC controller will be provided with a BACnet module for connection to the existing Energy Center BMS system.
 - .1 The Energy Center BMS system to monitor the status points provided by the PLC system only.
 - .2 Provide a new graphic within the existing graphics for the Flue Gas Economizer system.
- .2 The PLC controller is to be provided with enable signals and modulation signals for each of the existing fuel oil boilers in the Energy Center. Coordinate signal requirements with PLC panel and Energy Center BMS system as required. Signals may be provided via the PLC BACnet module and BACnet connection to the Energy Center BMS system.
- .2 Systems to operate in standby power operation and will NOT be monitored by the Polaris EMCS due to its location in the Energy Center.
 - .1 Monitoring of system will occur at the building via the supply/return water temperatures and BTU meter for the FGE system pumps.
- .3 A flow switch on the HWS piping downstream of the FGE and upstream of the HWR pipe to the emergency HEX will provide indication of flow and thus a demand for heating water production via the FGE or the emergency HEX.
 - .1 The flow switch will provide indication of flow via a green indicator light installed in the Emergency Heating System control panel.
- .3 Flue Gas Economizer System
 - .1 The FGE system is the primary source of heating energy for Polaris.
 - .2 The system will be controlled by the dedicated PLC controller supplied with the FGE. The sequences described in the following *italicized clauses* below are to be confirmed with the flue gas economizer manufacturer and may differ.
 - .3 FGE HWS setpoint = 63°C (user adjustable via system PLC controller).
 - .1 When maximum heating demands occurs or there are insufficient flue gasses available to meet the demand, the HWS temperature may drop to 60°C or lower. The FGE system will extract the maximum heat possible for the given situation.
 - .4 *The system will be enabled when the following conditions are met:*
 - .1 *The flow switch described under "General" above indicates flow in the economizer loop and thus a demand for heating.*
 - .2 *One or more of the boilers in the Energy Center is operating as determined indicated by a boiler enable and/or modulation signal from the Energy Center BMS system to the PLC controller.*
 - .3 *For the "enabled" boiler(s), the respective boiler chimney temperature as measure by a new temperature sensor installed in the respective existing boiler chimney upstream of the new tee for the take-off damper is above a minimum temperature setpoint.*
 - .1 *Boiler "ON" chimney temperature setpoint = 75°C (user adjustable via system PLC controller).*
 - .5 *When the system is enabled:*

- .1 *Bypass 2-way control valve to close and direct all economizer loop flow through the FGE. Bypass control valve to be open when FGE system not operating.*
- .2 *For each boiler determined to be "ON", the PLC controller to signal the respective boiler chimney damper to open and thus allow the FGE fan to draw boiler flue gases.*
 - .1 *End switches on the damper actuator will provide damper positing feedback.*
- .3 *PLC controller to modulate FGE fan speed and chimney dampers to maintain HWS temperature setpoint while not causing the FGE fan to draw in outdoor air via the chimney(s).*
 - .1 *The indication of outdoor air being drawn in a chimney would be a lower temperature measured immediately after the chimney take-off damper than the chimney temperature measured on the chimney upstream of the tee to the take-off damper less a differential.*
 - .2 *Boiler chimney dampers require modulation to prevent excess draw from a boiler that is not operating at full capacity.*
 - .3 *Boiler chimney temperature to take-off damper temperature differential = 5°C*
 - .1 *Modulation point to be calculated as boiler chimney temperature minus take-off damper temperature minus the differential such that a positive value indicates the take-off temperature is lower than the boiler chimney temperature and thus outside air is being drawn in via the top of the chimney outside.*
- .4 Emergency heating system (standalone panel)
 - .1 Emergency heating system to only be utilized when FGE system is not operational for an extended period of time, the electrical cost of heating the new building with the electric boilers is excessive, and there is excess heat available from the Energy Center heating plant. The system requires manual enabling and disabling in a two-step process. The emergency heating system is NOT intended to function as a long-term solution as directly affects the Zero-Carbon and Net-Zero Energy ratings of the new building when it is being used.
 - .2 System will be enabled by
 - .1 Manually opening the two normally closed isolation valves to the heat exchanger and closing the normally open bypass valve. This will redirect heating water through the heat exchanger.
 - .2 Manually enable the system modulating temperature controller via a selection switch on the local control panel.
 - .3 System will be disabled manually by the reverse of the above
 - .4 Once enabled, the modulating temperature controller to modulate the Energy Center side 2-way control valve to maintain the HWS temperature setpoint on the Polaris side of the heat exchanger.
 - .1 HWS setpoint = 63°C

- .1 While adjustable at the modulating temperature controller, this setpoint is intended to NOT be adjusted.
- .2 Control valve to be spring return and to fail closed.
- .5 The flow switch described under "General" above will allow enabling of the modulating temperature controller only when there is flow in the economizer heating water piping loop.
- .6 An amber indicator light in the system control panel to indicate when the modulating temperature controller has been enabled.

3.12 SOP - HEATING WATER SYSTEMS

- .1 Description
 - .1 Primary side is composed of the FGE and Thermal Storage Tank System, the Electric Boiler System, and the Waste Heat Recovery Heat Pump System.
 - .2 Secondary side is composed of the Secondary Heating Water System and Glycol Heating Water System
- .2 General
 - .1 Systems to operate in standby power operation and be monitored by the EMCS
 - .2 Indicate supply and return water temperatures for each system, temperature differentials, set point temperatures, set point differential, outdoor air temperature, and reset temperatures at OWS.
 - .3 The program shall have deadbands to prevent excessive pump and equipment cycling.
 - .1 Unless noted otherwise, the minimum pump run time once enabled shall be 10 minutes.
 - .2 Unless noted otherwise, the minimum pump stop time once disabled shall be 10 minutes.
 - .3 Unless noted otherwise, the minimum temperature deadband for setpoints shall be 2°C (4°F).
 - .4 Indicate trouble at OWS in event that the HWS temperature is 10° C less than HWST setpoint for period greater than 15 minutes.
 - .5 A primary heating water (economizer / electric boiler side of thermal storage tanks) reset schedule shall be provided to allow future use however no reset is required at initial building startup. The reset ratio and set points are to be adjustable by graphic operator interface at the OWS. The HWS temperature is to reset based on O/A temp.
Initial primary HWS reset schedule setpoints:

Outside Air Temperature	Heating Water Supply Setpoint
10°C	60.0°C (140°F)
-25°C	60.0°C (140°F)

- .1 *For information: the primary heating water reset schedule directly affects the amount of usable heating energy stored in the thermal storage tanks. A lower HWS setpoint temperature will mean a lower thermal storage tank temperature and thus less stored heating capacity.*
- .6 A secondary heating water (building side of thermal storage tanks) reset schedule shall be provided. The reset ratio and set points are to be adjustable by

graphic operator interface at the OWS. The HWS temperature is to reset based on O/A temp.

Initial secondary HWS reset schedule setpoints:

Outside Air Temperature	Heating Water Supply Setpoint
10°C	48.9°C (120°F)
-25°C	60.0°C (140°F)

- .3 Flue Gas Economizer Pumps and Thermal Storage Tank System
 - .1 The Flue Gas Economizer Pump and Thermal Storage Tank system is composed of the Flue Gas Economizer System (HEX-FGE, F-FGE), FGE circulation pumps (P-H-E1 and P-H-E2), and thermal storage tanks (T-H-1 and T-H-2).
 - .1 Refer to "SOP - Flue Gas Economizer" for the operation of the FGE System.
 - .1 Use of the FGE system or the "emergency heating system" does not affect the operation of this system as they are an either/or operation and provide the same heating water output, flow rate, and temperature.
 - .2 The temperature difference between the thermal storage tank temperature sensors installed at the highest and lowest temperature sensor ports shall be calculated for each thermal storage tank for use in operation and shall be referred to as the "thermal storage tank deltaT".
 - .2 The system is to be enabled when the secondary heating water system is enabled.
 - .3 The EMCS shall provide main/standby pump control.
 - .1 The main pump shall operate continuously when the system is enabled.
 - .2 The standby pump shall be energized upon a failure of a lead pump.
 - .3 Rotate the main pump on 168hr intervals. Indicate transfer at the OWS.
 - .4 Should the lead pump fail, indicate trouble to the OWS identifying the problem and activate standby pump.
 - .5 Should the lag pump fail, alarm to the OWS identifying the problem and activate callout.
 - .4 The EMCS shall modulate the pump speed to maintain the heating water temperature setpoint on the primary side and to maintain the thermal storage thermal storage tank deltaT.
 - .1 The lead pump shall be enabled at 30% speed.
 - .2 A time delay of 15 minutes shall be provided when all setpoints are satisfied.
 - .5 Temperature sensors installed on each of the thermal storage tanks are to be monitored by the EMCS.
 - .1 Should the thermal storage tank deltaT for either thermal storage tank exceed 5°C, the EMCS shall enable the lead FGE pump if not enabled and shall modulate the pump speed to 100%. The lead pump shall run continuously at 100% speed until the thermal storage tank deltaT reduces to 2°C.

- .2 Should the thermal storage tank deltaT exceed 5°C for greater than 2 hours, a cautionary alert shall be generated at the OWS.
- .3 Should the thermal storage tank deltaT exceed 5°C for greater than 4 hours, an alarm shall be generated at the OWS and alarm callout be sent.
- .4 Chilled Water Waste Heat Recovery System
 - .1 The waste heat recovery system consists of two circulation pumps P-C-R1 (chilled water system), P-H-R1 (heating water system) and a water-to-water heat pump (HP-R-1). The system recovers heat from the chilled water system for use in the heating water system.
 - .2 The system is to be enabled when there is a simultaneous need for heating and cooling as determined by both the secondary heating water system and secondary chilled water system being enabled simultaneously.
 - .3 When system enabled:
 - .1 Both circulation pumps to operate continuously.
 - .2 Heat pump to modulate its heating output to maximize heat recovered from chilled water system while maintaining secondary chilled water system supply water temperature.
 - .1 Refer to "SOP - Chilled Water System" for the setpoint.
 - .4 Upon a failure of the heat pump or either of the circulation pumps, an alarm shall be generated at the OWS and the system shall be disabled.
- .5 Electric Boiler System
 - .1 The electric boiler system is composed of the two electric boilers (B-1 and B-2) and their associated circulation pump (P-H-B1 and P-H-B2).
 - .2 The electric boilers are to only be enabled if the primary HWS temperature is 5°C below the primary HWS setpoint for more than 10 minutes AND EITHER:
 - .1 The FGE system is not operation (i.e. offline due to issue with system); OR
 - .2 The thermal storage tanks have been exhausted of their usable heat energy (as defined above under the Flue Gas Economizer and Thermal Storage Tank System) and the FGE system cannot meet the demand alone.
 - .3 The heating boilers shall operate in lead/lag sequence and rotate as follows:
 - .1 Lead boiler to change after total runtime of 168 hr.
 - .2 Lag boiler to start if lead boiler is enabled AND HWS temperature is 5°C below HW supply setpoint for more than 5 minutes.
 - .4 When enabled, boiler packaged controls to cycle/modulate boiler elements to maintain primary side HWS temperature setpoint
 - .5 When lead boiler energized, associated boiler primary circulation pump to be enabled first and status to be confirmed before enabling boiler.
 - .6 When a boiler is disabled, its circulation pump shall continue to operate for 5 minutes to dissipate any residual heat in the boiler.
 - .7 Last boiler enabled to be disabled when HWS supply temperature is above HW supply setpoint for more than 5 minutes.

- .8 Should the running boiler or circulation pump fail, the other boiler and pump shall be enabled, and the previous boiler circulation pump and boiler shall be disabled. Upon a failure of the boiler or associated pump, an alarm shall be generated at the OWS.
- .9 Safety Controls:
 - .1 Low water cutoff (LWCO) to disable boiler in event of low heating water level.
 - .2 High limit controller with manual reset to disable boiler in event of high heating water temperature. Setpoint = 80° C.
- .6 Secondary Heating Water System
 - .1 The secondary heating system consists of two circulation pumps P-H-1 and P-H-2. Both pumps are complete with integral variable frequency drives and are sized for 100% capacity each.
 - .2 As a result of the piping connections between the secondary heating water and the primary side, the secondary heating water system will utilize heat as follows:
 - .1 Thermal storage tanks when all primary side systems are not in operation (FGE pumps, heat recovery system, electric boiler system)
 - .2 Combination of the FGE pumps and thermal storage tanks (subject to FGE pump flow rate) when the FGE pumps are operating.
 - .3 Combination of the electric boiler system and thermal storage tanks (subject to electric boiler operation) when the FGE system is not operational.
 - .4 When the chilled water waste heat recovery system is operating, it will add additional heat and offset heat required from the FGE system, thermal storage tanks and electric boilers (if FGE system is not operational).
 - .3 The secondary heating system is normally activated via the EMCS when the outside air temperature is below the secondary heating system enable setpoint for a time period greater than the enable anti-short cycle period. The system shall be disabled when the outside air temperature is at or above the secondary heating system enable setpoint for a time period greater than the disable anti-short cycle period
 - .1 System enable OA setpoint = 16°C
 - .2 Initial enable anti-short cycle period = 2 hours.
 - .3 Initial disable anti-short cycle period = 1 hours.
 - .4 The EMCS shall provide main/standby pump control.
 - .1 The main pump shall operate continuously when the system is enabled.
 - .2 The standby pump shall be energized upon a failure of a lead pump.
 - .3 Rotate the main pump on 168hr intervals. Indicate transfer at the OWS.
 - .5 The pump integral variable speed drives are to modulate to maintain a constant differential pressure as measured across the pump as measured by the pump's integral pressure sensors.
 - .6 Should the lead pump fail, indicate trouble to the OWS identifying the problem and activate standby pump.

- .7 Should the lag pump fail, alarm to the OWS identifying the problem and activate callout.
- .8 Indicate secondary HWS and HWR temperatures at the OWS. If the supply temperature is greater than 5°C below the secondary reset HWS temp for 30min or longer, then alarm failure.
- .9 Indicate secondary HW system pressure (as measured by sensor at expansion tanks). Alarm if pressure is outside low/high range for greater than 5 minutes.
 - .1 Low pressure setpoint = 103 kPa (confirm setpoint during TAB)
 - .2 High pressure setpoint = 207 kPa (confirm setpoint during TAB)
- .7 Glycol Heating Water System
 - .1 The glycol heating system consists of a water to glycol heat exchange with a modulating 2-way control valve on the water (hot) side of the heat exchanger and two circulation pumps P-H-G1 and P-H-G2 on the glycol (cold) side of the heat exchanger. Both pumps are complete with integral variable frequency drives and are sized for 100% capacity each.
 - .2 The glycol heating system is normally activated via the EMCS when the outside air temperature is below the secondary heating system enable setpoint AND EITHER:
 - .1 ERV-1 and/or ERV-2 re-heat coils S/A temperature setpoint has not been met for greater than 5 minutes; OR
 - .2 MAU-1 fan has been enabled; OR
 - .3 Outside air temperature is less than 10°C for greater than 2 hours.
 - .3 The EMCS shall provide main/standby pump control.
 - .1 The main pump shall operate continuously when the system is enabled.
 - .2 The standby pump shall be energized upon a failure of a lead pump.
 - .3 Rotate the main pump on 168hr intervals. Indicate transfer at the OWS.
 - .4 The 2-way control valve shall modulate to maintain the GLS temperature equal to the HWS temperature setpoint less a differential to account for the heat transfer via the heat exchanger.
 - .1 HWS to GLS differential = 2.75°C (5°F)
 - .1 The differential shall NOT be user adjustable.
 - .5 The pump integral variable speed drives are to modulate to maintain a constant differential pressure as measured across the pump as measured by the pump's integral pressure sensors.
 - .6 Should the lead pump fail, indicate trouble to the OWS identifying the problem and activate standby pump.
 - .7 Should the lag pump fail, alarm to the OWS identifying the problem and activate callout.
 - .8 Indicate GLS and GLR temperatures at the OWS. If the supply temperature is greater than 5°C below the secondary reset HWS temp for 30min or longer, then alarm failure.
 - .9 Indicate secondary GL system pressure (as measured by sensor at expansion tank). Alarm if pressure is outside low/high range for greater than 5 minutes.
 - .1 Low pressure setpoint = 103 kPa (confirm setpoint during TAB)

- .2 High pressure setpoint = 207 kPa (confirm setpoint during TAB)

3.13 SOP - CHILLED WATER SYSTEMS

- .1 Description
 - .1 Primary side is composed of the chillers and associated circulation pumps.
 - .2 Secondary side is composed of the secondary chilled water system and the Waste Heat Recovery Heat Pump System.
- .2 General
 - .1 Systems to operate in standby power operation and be monitored by the EMCS
 - .2 Indicate supply and return water temperatures for each system, temperature differentials, set point temperatures, set point differential, outdoor air temperature, and reset temperatures at OWS.
 - .3 The program shall have deadbands to prevent excessive pump and equipment cycling.
 - .1 Unless noted otherwise, the minimum pump run time once enabled shall be 10 minutes.
 - .2 Unless noted otherwise, the minimum pump stop time once disabled shall be 10 minutes.
 - .3 Unless noted otherwise, the minimum temperature deadband for setpoints shall be 2°C (4°F).
 - .4 Indicate trouble at OWS in event that the CHWS temperature is 5° C more than CWST setpoint for period greater than 15 minutes.
 - .5 A chilled water reset schedule shall be provided. The reset ratio and set points are to be adjustable by graphic operator interface at the OWS. The CHWS temperature is to reset based on O/A temp.
Initial CHWS reset schedule setpoints:

Outside Air Temperature	Chilled Water Supply Setpoint
24°	6°C (42.8°F)
16°C	12°C (53.6°F)

- .3 Chilled Water Waste Heat Recovery System
 - .1 Refer to "Waste Heat Recovery System" under the "SOP - Heating Water System" above for operation.
- .4 Chilled Water Primary System
 - .1 The chilled water system is composed of the two air-cooled chillers (CH-1 and CH-2) and their associated circulation pump (P-C-C1 and P-C-C2).
 - .2 The chillers are to only be enabled if the primary CHWS temperature is 5°C above the primary CHWS setpoint for more than 10 minutes
 - .3 The chillers shall operate in lead/lag sequence and rotate as follows:
 - .1 Lead chiller to change after total runtime of 168 hr.
 - .2 Lag chiller to start if lead chiller is enabled AND CHWS temperature is 3°C above CHWS setpoint for more than 5 minutes.
 - .4 When enabled, chiller packaged controls to cycle/modulate chiller stages to maintain primary side CHWS temperature setpoint

- .5 When lead chiller is energized, associated chiller primary circulation pump to be enabled first and status to be confirmed before enabling chiller.
 - .6 Last chiller enabled to be disabled when CHWS supply temperature is below CHWS setpoint for more than 5 minutes.
 - .7 Should the running chiller or circulation pump fail, the other chiller and pump shall be enabled, and the previous chiller circulation pump and boiler shall be disabled. Upon a failure of the chiller or associated pump, an alarm shall be generated at the OWS.
- .5 Secondary Chilled Water System
- .1 The secondary chilled water system consists of two circulation pumps P-C-1 and P-C-2. Both pumps are complete with integral variable frequency drives and are sized for 100% capacity each.
 - .2 The secondary chilled water system is normally activated via the EMCS when the outside air temperature is above the secondary chilled water system enable setpoint for a time period greater than the enable anti-short cycle period. The system shall be disabled when the outside air temperature is at or below the secondary chilled water system enable setpoint for a time period greater than the disable anti-short cycle period
 - .1 System enable OA setpoint = 16°C
 - .2 Initial enable anti-short cycle period = 2 hours.
 - .3 Initial disable anti-short cycle period = 1 hours.
 - .3 The secondary chilled water system shall also be enabled if the space cooling temperature setpoint cannot be met for greater than 10 minutes for the following fancoils:
 - .1 FCU-27, P1057 - Network & Security Room
 - .2 FCU-28, P1030 - Main Electrical Room and P1030A - Emergency Distribution Room
 - .4 The EMCS shall provide main/standby pump control.
 - .1 The main pump shall operate continuously when the system is enabled.
 - .2 The standby pump shall be energized upon a failure of a lead pump.
 - .3 Rotate the main pump on 168hr intervals. Indicate transfer at the OWS.
 - .4 Should the lead pump fail, indicate trouble to the OWS identifying the problem and activate standby pump.
 - .5 Should the lag pump fail, alarm to the OWS identifying the problem and activate callout.
 - .5 The pump integral variable speed drives are to modulate to maintain a constant differential pressure as measured across the pump as measured by the pump's integral pressure sensors.
 - .6 Indicate secondary CHWS and CHWR temperatures at the OWS. If the supply temperature is greater than 5°C above the secondary reset CHWS temp for 30min or longer, then alarm failure.
 - .7 Indicate secondary GL system pressure (as measured by sensor at expansion tank). Alarm if pressure is outside low/high range for greater than 5 minutes.
 - .1 Low pressure setpoint = 103 kPa (confirm setpoint during TAB)

- .2 High pressure setpoint = 207 kPa (confirm setpoint during TAB)

3.14 SOP - MAIN ENERGY RECOVERY VENTILATORS

- .1 Description
- .1 In the context of this SOP:
- .1 Supply air refers to supply air ductwork from the supply air header duct connected to ERV-1/2 supply connections that provides tempered outside air to the various fancoils, constant volume regulators, and VAV boxes throughout the building.
- .2 Return air refers to the return air ductwork to the return air header duct connected to ERV-1/2 return connections from the lab area and the general (non-lab) areas of the building.
- .3 Washroom exhaust air refers to the exhaust air ductwork to the return air header duct connected to ERV-1/2 return connections from the various washrooms and janitor rooms throughout the building
- .2 The two large energy recovery ventilators (ERV-1 & ERV-2) operate in parallel and are a Dedicated Outdoor Air Systems (DOAS) which provides the minimum required outside to maintain space air quality. They provide tempered outside air to supply DOAS fancoils, fancoils with VAV boxes, and constant air volume regulators and provide exhaust air from laboratory exhaust air VAV boxes and washroom exhaust.
- .3 Each ERV consists of a remotely installed outside air damper, a dual exhaust multi-damper switchover section complete with actuators, a filter section, a supply fan complete with variable frequency drive and BACnet card, a remotely installed exhaust air damper, an exhaust fan complete with variable frequency drive and BACnet card, an externally duct mounted pre-heat coil, and an externally duct mounted re-heat coil.
- .4 The two ERVs provide their respective S/A to a common S/A duct header within the mechanical room and take their respective R/A from a common R/A duct header in the mechanical room.
- .5 The system will be required to operate continuously to maintain the lab area negative pressurization with respect to the surrounding areas at all times. System shall not stop unless servicing is required or a failure occurs.
- .6 The system has several airflow monitoring stations located at key points in the ductwork. The airflow monitoring stations are intended to provide additional monitoring points to assist in the modulation of the ERV system supply air and return air resulting for the various outside air and return/exhaust air ventilation equipment.
- .1 The supply air mains off the common supply air header duct.
- .2 The return air mains near the common return air header duct.
- .3 The washroom/janitor room exhaust air main near the common return air header duct.
- .2 General
- .1 Systems to operate in standby power operation and be monitored by the EMCS
- .2 The EMCS shall provide lead/lag control of the two ERVs
- .1 The lead ERV shall operate continuously when the system is enabled.

- .2 The lag ERV shall be energized upon a failure of the lead ERV.
- .3 Rotate the lead ERV on 168hr intervals. Indicate transfer at the OWS.
- .3 System Start/Stop
 - .1 The air system shall be energized contiguously via the EMCS to maintain the minimum O/A setpoint required for the laboratory unoccupied E/A airflows.
 - .2 Upon system start-up, lead ERV to be enabled as follows and shall modulate to the minimum O/A setpoint required for the laboratory unoccupied E/A airflows.
 - .3 Upon lead ERV enable, position dampers to free cooling or heat recovery mode based on heating/cooling demand. The outdoor air dampers shall be energized open. Once the damper end switch indicates that the damper is open, the supply fan shall be started. After a 5 second time delay, the exhaust air dampers shall be energized open. Once the damper end switch indicates that the damper is open, the exhaust fan shall be started.
 - .4 Provide a point on the graphics to allow the building operators to disable each ERV.
- .4 Fan Speed Control
 - .1 EMCS shall modulate lead ERV supply fan speed and exhaust fan speed to maintain the end- of-line static pressure setpoints as determined by the air balance.
 - .2 When the lead ERV fan speeds required to maintain end-of line duct static pressure setpoints are greater than 90%, the EMCS to enable the lag ERV.
 - .1 Lag ERV to be enabled per the above "System Start/Stop".
 - .2 Once the lag ERV is enabled, EMCS to modulate both ERVs in parallel to maintain end-of line duct static pressure setpoints.
 - .3 When the combined ERV fan speeds required to maintain end-of line duct static pressure setpoints reduce to less than 45%, the EMCS to disable the lag ERV and increase the lead ERV fan speeds to maintain end-of line duct static pressure setpoints.
- .5 Temperature Control
 - .1 The dual exhaust multi-damper switchover section shall be controlled to provide heating during heat recovery mode and cooling during cooling recovery mode.
 - .1 If exhaust air drops below 21°C, dual exhaust dampers shall switch to heat recovery mode.
 - .2 If exhaust air rises above 23°C and outside air is above 15°C, dual exhaust dampers shall switch to free cooling mode.
 - .3 If exhaust air rises above 21°C and outside air is below 15°C, dual exhaust dampers shall switch to heat recovery mode until outside air is above 15°C, then they shall revert to free cooling mode.
 - .2 Pre-heat coil
 - .1 The pre-heat coil shall modulate to maintain the O/A pre-heat temperature setpoint to prevent unit frosting when operating at or below -40°C.
 - .1 Pre-heat coil setpoint = -39°C
 - .1 The setpoint shall NOT be user adjustable.

- .2 A note on the OWS graphics shall read "PHC setpoint is -39°C. ERV does not require pre-heat at or above -39°C".
- .3 Re-heat coil
 - .1 The re-heat coil shall modulate to maintain the S/A temperature setpoint.
 - .1 Re-heat coil setpoint = 16°C
- .6 Airflow monitoring stations
 - .1 EMCS to monitor airflow monitoring stations and utilize airflows in conjunction with the various fancoil outside air inlet module air flows, supply air VAV box outside air inlet module airflows, constant volume regulator (CVR) damper outside air volumes (as set/measured during TAB), lab exhaust VAV box exhaust airflows, and building general return air VAV box return airflow in calculations to determine required ERV-1/2 outputs
 - .2 Supply airflow monitoring stations:
 - .1 Lab supply air, located above SB1026 (Wet Lab - Chemistry) near gridline 3
 - .2 Building (non-lab) supply air, located above SB1031 (Water Room) near east wall
 - .1 This station requires an offset of 95 L/s as the take-offs FCU-24 CVR (85 L/s) and FCU-28 CVR (10 L/s) occur before the station. Confirm the airflows with the TAB report.
 - .3 Return airflow monitoring stations:
 - .1 Lab return air, located above SB1032 (Mechanical Room) near gridline C:3.
 - .2 Building (non-lab) return air, located above SB11031 (Water Room) near west wall
 - .4 Washroom exhaust airflow monitoring stations:
 - .1 Washroom/Janitor room exhaust air, located above SB1031 (Water Room) near west wall
- .7 The following conditions for ERVs will cause a trouble signal:
 - .1 The ERV SF or EF operating outside their normal parameters for two minutes.
 - .2 Any of the temperature sensors for ERVs detect temperatures outside their normal parameters for five minutes.
 - .3 The static pressure sensors for ERVs detecting static pressures outside their normal parameters for five minutes.
 - .4 The differential pressure sensors across the filters detect a pressure drop outside their normal range.
 - .5 If the supply air temperature is 5degC below reset temperature for greater than 15 minutes.
 - .6 If the supply air flow is at least 15% below the minimum setpoint for five minutes.
- .8 The following conditions for the ERV will cause a failure alarm at the OWS and cause the ERV to go to fail mode with fans off and dampers to close. Terminal units to remain in day mode. Provide a manual software reset to restart the ERV.

- .1 The ERV supply air temperature is 10°C below reset temperature for greater than 5 minutes.
- .2 Failure of either SF or EF motors.

3.15 SOP - LOADING DOCK ENERGY RECOVERY VENTILATOR

- .1 Description
 - .1 The small energy recovery ventilator (ERV-3) is a constant volume 100% outside air system that serves the combined loading dock, storage area, and garbage/recycling area. The system provides the minimum required O/A to meet the required space E/A airflows.
 - .2 The ERV consists of a remotely installed outside air damper, a dual exhaust multi-damper switchover section complete with actuators, a filter section, a supply fan complete with a variable speed ECM motor, a remotely installed exhaust air damper, an exhaust fan complete with a variable speed ECM motor, and an externally duct mounted re-heat coil.
- .2 General
 - .1 System to operate in standby power operation and be monitored by the EMCS
- .3 System Start/Stop
 - .1 The air system shall be energized via the EMCS occupancy scheduled.
 - .2 Upon system start-up, position dampers to free cooling or heat recovery mode based on heating/cooling demand. The outdoor air dampers shall be energized open. Once the damper end switch indicates that the damper is open, the supply fan shall be started. After a 5 second time delay, the exhaust air dampers shall be energized open. Once the damper end switch indicates that the damper is open, the exhaust fan shall be started.
 - .3 Provide a point on the graphics to allow the building operators to disable the unit.
- .4 Temperature Control
 - .1 The dual exhaust multi-damper switchover section shall be controlled to provide heating during heat recovery mode and cooling during cooling recovery mode.
 - .1 If exhaust air drops below 21°C, dual exhaust dampers shall switch to heat recovery mode.
 - .2 If exhaust air rises above 21°C and outside air is above 15°C, dual exhaust dampers shall switch to free cooling mode.
 - .3 If exhaust air rises above 21°C and outside air is below 15°C, dual exhaust dampers shall switch to heat recovery mode until supply air is above 15°C, then they shall revert to free cooling mode.
 - .2 Re-heat coil
 - .1 The re-heat coil shall modulate to maintain the S/A temperature setpoint.
 - .1 Re-heat coil setpoint = 16°C
- .5 The following conditions for ERVs will cause a trouble signal:
 - .1 The ERV SF or EF operating outside their normal parameters for two minutes.
 - .2 Any of the temperature sensors for ERVs detect temperatures outside their normal parameters for five minutes.

- .3 The static pressure sensors for ERVs detecting static pressures outside their normal parameters for five minutes.
- .4 The differential pressure sensors across the filters detect a pressure drop outside their normal range.
- .5 If the supply air temperature is 5degC below reset temperature for greater than 15 minutes.
- .6 If the supply air flow is at least 15% below the minimum setpoint for five minutes.
- .6 The following conditions for the ERV will cause a failure alarm at the OWS and cause the ERV to go to fail mode with fans off and dampers to close. Provide a manual software reset to restart the ERV.
 - .1 The ERV supply air temperature is 10degC below supply temperature setpoint for greater than 5 minutes.
 - .2 Failure of either SF or EF motors.

3.16 SOP - DUCTED FUME HOODS AND MAKE-UP AIR

- .1 Description
 - .1 The system consists of the 3 ducted fume hoods and their associated fume hood exhaust fans and the fume hood make-up air system.
 - .2 Each of the ducted fume hoods will have a packaged "Ducted Fume Hood Controller and Face Velocity Monitor/Alarm Device" with a sash position sensor. The controller is referred to as the "FH controller" herein.
 - .1 Refer to Section 25 30 02 - Field Control Devices clause 2.26 for the fume hood controller requirements.
 - .3 Each fume hood exhaust fan includes an isolation damper and a variable volume O/A bypass damper and plenum to allow variable volume fume hood exhaust airflow rates and a controller. The controller is referred to as the "FH-EF controller" herein.
 - .1 Refer to Section 223 34 00 - HVAC Fans clause 2.6 for the fume hood exhaust fan controller requirements.
 - .4 The fume hood make-up air system consists of a rooftop outside air intake fan (direct drive) with weatherhood and filter, make-up air isolation control damper at roof penetration, interior final filter, interior hydronic heating coil, and 3 remotely mounted supply air isolation control dampers to allow direction of supply air to specific rooms. There is no packaged controller for this system.
- .2 General
 - .1 Systems to operate in standby power operation and be monitored by the EMCS
- .3 System Start/Stop
 - .1 Each FH controller to provide:
 - .1 Enable signal for its associated FH-EF controller.
 - .2 Modulation signal for the bypass damper controlled by its associated FH-EF controller.
 - .3 Enable (open) signal for its associated supply air isolation damper.
 - .2 Each fume hood exhaust fan shall be enabled via its dedicated FH-EF controller via an enable signal from the FH controller installed on each fume hood.

- .1 On enable, the FH-EF controller to start the constant speed exhaust fan and modulate the fume hood bypass air damper to the position that corresponds to the fume hood sashed closed position.
- .2 The FH controller position sensor will be used by the FH controller to determine the fume hood face velocity and thus the required exhaust air flow to maintain the fume hood face velocity at its required setpoint. The FH controller will provide a modulating signal to the respective FH-EF controller for the required exhaust airflow.
 - .1 Fume hood face velocity setpoint = 60 FPM +5 FPM / -0 FPM
- .3 The FH-EF controller to modulate the fume hood exhaust fan bypass air damper position based on the modulating signal from the FH controller to maintain the required exhaust airflow from fume hood.
- .3 Each supply air isolation damper shall be opened by its associated FH controller when the fume hood is enabled. An end switch will provide status on damper position.
- .4 Fume hood make-up air system to be enabled if any of the fume hoods are operating and the total fume hood exhaust air exceeds the makeup air unit minimum flow rate.
 - .1 Minimum total fume hood exhaust for makeup air unit enable = 60 L/s
 - .1 Below the enable setpoint make-up air for the fume hoods will be available via transfer air and outside air provided to the lab spaces.
 - .2 On enable, the make-up air isolation damper at the roof penetration to open. Once the damper end switches prove open, the make-up air unit supply fan to start at minimum speed.
 - .3 Once startup complete, the make-up air unit supply fan speed to be modulated to maintain the calculated required supply air volume based on the combined modulating signal from each fume hood air flow monitor and controller.
 - .1 One, two, or all three ducted hoods may be used at same time and their sash positions may be different or the same. The ducted fume hood air flows for a single hood (confirm airflows with ducted fume hoods supplied for project) are per the following table. The total fume hood exhaust air will be various combinations of the airflows below. Make-up air flows are 10% less than the exhaust airflows.

Fume hood sash position	Exhaust Airflow (L/s)	Make-up Airflow (L/s)
Fume hood off	0	0
Fume hood on with sash closed	33	30
Fume hood on with sash at 18" position (partial open)	203	180
Fume hood on with sash at 28" position (full open)	326	290

- .4 Temperature Control
 - .1 On enable of the make-up air system, the re-heat coil shall modulate to maintain the S/A temperature setpoint.

- .2 Re-heat coil setpoint = 16°C
- .4 The following conditions for make-up air system and fume hood EFs will cause a trouble signal:
 - .1 The make-up air fan or fume hood EFs are operating outside their normal parameters for two minutes.
 - .2 Any of the temperature sensors for the make-up air system detect temperatures outside their normal parameters for five minutes.
 - .3 The differential pressure sensors across the filters detect a pressure drop outside their normal range.
 - .4 If the supply air temperature is 3 degC below the temperature setpoint for greater than 5minutes.
 - .5 If the supply air flow is at least 10% below the minimum setpoint for 2 minutes.
- .5 The following conditions for the make-up air system will cause a failure alarm at the OWS and cause the make-up air system to go to fail mode with fan off and dampers to close. Provide a manual software reset to restart the make-up air system.
 - .1 The make-up air system supply air temperature is 10°C below reset temperature for greater than 5 minutes.
 - .2 Failure of the make-up air fan motor.

3.17 SOP - CHEMICAL STORAGE CABINET EXHAUST FAN

- .1 The chemical storage cabinet exhaust fan provides a common exhaust for all of the chemical storage cabinets located within the lab areas.
- .2 The chemical storage cabinet exhaust fan is to run continuously. A local disconnect will allow stopping of fan only for servicing.
- .3 EMCS to monitor status of fan via a current sensor and to alarm if fan is not operating.
- .4 System to operate in standby power operation and be monitored by the EMCS.

3.18 SOP - INSTRUMENTS LAB FUME EXTRACTION ARM EXHAUST FAN

- .1 A wall mounted adjustable fume extraction arm provides a flexible local source capture exhaust for various activities and equipment that may occur/be used in the Instruments Lab.
- .2 The fume extraction arm exhaust fan is controlled by a local on/off switch.
- .3 EMCS to monitor status of fan via a current sensor and to alarm if fan has been continuously running for greater than 24 hours.
- .4 System to operate in standby power operation and be monitored by the EMCS.

3.19 SOP - SMUDGING EXHAUST FAN

- .1 Description
 - .1 One Smudging Exhaust fan system serves the Ceremony Room (SB1009) and a second serves the Knowledge Sharing Space (SB1012)
 - .2 Both systems consist of a roof top mounted exhaust fan with control damper and a control damper on the transfer air duct from the room to the adjacent corridor.
- .2 System Start/Stop

- .1 A 0 to 2 hr spring return timer located near the room door / light switch will enable the system.
 - .1 A smoke detector installed in the transfer air duct to the corridor will also enable the system in case of user error and will indicate an alarm.
- .2 On system enable, transfer air duct control damper to close and exhaust fan control damper to open. Damper end switches on the transfer air and exhaust air damper to provide damper status to the EMCS. Once exhaust fan control damper end switch indicates the damper is open, the exhaust fan shall be started. The fancoil serving the room is to modulate its O/A damper to the maximum position.
- .3 System to remain enabled while timer active. Once timer expires, system to stop exhaust fan and return dampers to normal positions.
 - .1 Should transfer duct smoke detector indicate smoke, system to be re-enabled for 10 minutes.
- .4 Indicator lights located near the room door / light switch will provide user indication for the system.
 - .1 A solid green indicator light will indicate when the system has been enabled and is functioning correctly.
 - .2 A flashing red indicator light will indicate:
 - .1 System has not been enabled via the spring timer but the smoke detector has detected smoke and enabled the system.
 - .2 System has been enabled via the spring timer however a damper status has not been proven or the exhaust fan has failed to start.

3.20 SOP - MECHANICAL ROOM COOLING

- .1 The cooling fan (F-C-1) system provides economizer free cooling to Mechanical Room.
- .2 The supply fan is to cycle to satisfy the room set point adjustable at the OWS. When the supply fan is on, modulate the O/A, E/A, and R/A dampers to maintain discharge air temperature SAT at set point.
 - .1 Initial SAT setpoint = 18°C
- .3 If the discharge air temp is lower than the setpoint by 5°C or more for greater than 5 minutes lock out the cooling fan and alarm.
- .4 If the Mechanical Room temperature exceeds 35degC for longer than 15min then alarm to the OWS.
- .5 If the supply fan is supposed to be operating and the current sensor does not detect the proper current draw for 30 seconds, alarm to the OWS.
- .6 On a high-pressure drop at the filters, indicate trouble to the OWS. Set point to be field determined and adjustable at OWS.
- .7 The following conditions for the make-up air system will cause a failure alarm at the OWS and cause the cooling fan system to go to fail mode with fan off and O/A and E/A dampers to close. Provide a manual software reset to restart the system.
 - .1 The cooling fan supply air temperature is 10°C below reset temperature for greater than 5 minutes.
 - .2 The cooling fan supply freeze-stat has been tripped for greater than 1 minute.

- .8 System to operate in standby power operation and be monitored by the EMCS.

3.21 SOP - WATER ROOM COOLING

- .1 The cooling fan (F-C-2) system provides free cooling and humidity control for the Water Room.
- .2 The supply fan is to cycle to satisfy the room set point adjustable at the OWS. When the supply fan is on, open the O/A and E/A dampers.
- .1 Initial space setpoint = 24°C
- .3 If the space air temp is below 10°C for longer than 5 minutes lock out the cooling fan and alarm.
- .4 If the space temperature exceeds 35degC for longer than 15min then alarm to the OWS.
- .5 If the supply fan is supposed to be operating and the current sensor does not detect the proper current draw for 30 seconds, alarm to the OWS.
- .6 On a high-pressure drop at the filters, indicate trouble to the OWS. Set point to be field determined and adjustable at OWS.
- .7 The following conditions for the make-up air system will cause a failure alarm at the OWS and cause the cooling fan system to go to fail mode with fan off and O/A and E/A dampers to close. Provide a manual software reset to restart the system.
- .1 The cooling fan supply air temperature is 10°C below reset temperature for greater than 5 minutes.
- .2 The cooling fan supply freeze-stat has been tripped for greater than 1 minute.
- .3 Override:
- .1 Should the fire pump be operating while the either or all of the above conditions are true, the EMCS shall override the manual reset for 5 minutes if there is a call for space cooling and allow the system to operate as if no alarm was present. Should the space temperature be satisfied before the end of the override duration and the alarm conditions still exist, the EMCS shall re-instate the manual enable.
- .2 An alarm shall be generated and callout occur if override for fire pump is active.
- .3 *For information: NFPA standards require cooling ventilation systems for spaces that contain a fire pump.*
- .8 System to operate in standby power operation and be monitored by the EMCS.

3.22 SOP - EXHAUST VAV CONTROL

- .1 The exhaust VAV boxes modulate E/A airflows from the laboratories and from the corridor near the lecture hall and are connected to the R/A connection to the ERV-1/2 system. In conjunction with the E/A from the various washrooms, they make up the R/A to the ERV-1/2 system.
- .2 Laboratory E/A VAV (VAV-E-12 to VAV-E-20) boxes to modulate based on room occupancy as detected by room light switch or occupancy (motion) detector.
- .1 Laboratory space to have constant E/A regardless of occupied status to maintain negative pressurization relative to surrounding spaces to ensure no migration of fumes, odors, and other air borne contaminants to other spaces.

- .2 When lab space is occupied, space E/A VAV box to fully open to provide 6 ACH of E/A from space.
- .3 When lab space is unoccupied, space E/A VAV box to modulate to provide 1 ACH of E/A from space.
- .3 The general space E/A VAV box (VAV-E-1) to modulate as required to maintain the balance of ERV-1/2 system R/A required to meet the building's O/A airflow requirements where additional R/A is required in excess of the combined E/A from the Laboratories and E/A from the washrooms.
- .4 System to operate in standby power operation and be monitored by the EMCS.

3.23 SOP - FANCOIL UNIT WITH VAV BOX CONNECTION

- .1 The fancoil unit is to provide heat and cooling for the space(s) it serves and the associated VAV box will provide demand control O/A.
 - .1 Applicable fancoil units:
 - .1 FCU-1, SB1002 - Lecture Hall
 - .2 FCU-2, SB1002 - Lounge / Event Space
 - .2 Combination space thermostat and CO2 sensor to be installed in each space at the locations indicate on the plans and will provide heating/cooling and CO2 level control for the space.
 - .1 EMCS to use the average of the space thermostat temperatures as the space temperature.
 - .2 EMCS to use the highest of the space CO2 sensors as the space CO2.
 - .3 During occupied periods:
 - .1 Fancoil fan to operate continuously and the VAV O/A inlet damper to modulate to the space's minimum O/A setpoint.
 - .2 On rise in space CO2 level above setpoint as measured at space thermostat/CO2 sesnsor, VAV box O/A damper to modulate open to maintain the space CO2 setpoint.
 - .3 On call for heating, heating control valve to modulate to maintain space heating setpoint.
 - .4 On call for cooling, cooling control valve to modulate to maintain space cooling setpoint.
 - .4 During unoccupied periods:
 - .1 Fancoil fan to stop and VAV box O/A inlet damper to close.
 - .2 On call for heating, fancoil fan to start and heating control valve to modulate to maintain space heating setpoint. VAV box O/A inlet damper to remain closed.
 - .3 On call for cooling, fancoil fan to start and cooling control valve to modulate to maintain space cooling setpoint. VAV box O/A inlet damper to remain closed.
 - .5 Setpoints
 - .1 Heating = 18°C
 - .2 Cooling = 23°C
 - .3 CO2 level:

Space	CO2 level (ppm)
Lecture Hall	800
Lounge / Event Space	800

- .6 Alarm at OWS if carbon dioxide concentration exceeds a room's setpoints by more than 10% for 10 minutes
- .7 On a high-pressure drop at the filters, alarm to the OWS. Set point to be field determined and adjustable at OWS.
- .8 System to operate in standby power operation and be monitored by the EMCS.

3.24 SOP - FANCOIL UNIT WITH DOAS CONNECTION, NON LABORATORY SPACES

- .1 The fancoil unit is to provide demand control O/A and heat and cooling for the space(s) it serves.
 - .1 Applicable fancoil units: all FCU except FCU-1, FCU-2, FCU-12 to FCU-20, FCU-22 to FCU-24, FCU-28, FCU-29, FCU-32, and FCU-33.
- .2 A combination space thermostat and CO2 sensor to be installed in each space at the location indicate on the plans and will provide heating/cooling and CO2 level control for the space.
- .3 During occupied periods:
 - .1 Fancoil fan to operate continuously and the O/A inlet damper to modulate to the space's minimum O/A setpoint.
 - .2 On rise in space CO2 level above setpoint as measured at space thermostat/CO2 sensor, O/A damper to modulate open to maintain the space CO2 setpoint.
 - .3 On call for heating, heating control valve to modulate to maintain space heating setpoint.
 - .4 On call for cooling, cooling control valve to modulate to maintain space cooling setpoint.
- .4 During unoccupied periods:
 - .1 Fancoil fan to stop and O/A inlet damper to close.
 - .2 On call for heating, fancoil fan to start and heating control valve to modulate to maintain space heating setpoint.
 - .3 On call for cooling, fancoil fan to start and cooling control valve to modulate to maintain space cooling setpoint.
- .5 Setpoints
 - .1 Heating = 18°C
 - .2 Cooling = 23°C
 - .3 CO2 level:

Space	CO2 level (ppm)
Office	700
Student & Staff Work Zone	700
Welcome / Admin	800
Knowledge Sharing / Maker	800
Classroom	800
Ceremony Room	800

- .6 Alarm at OWS if carbon dioxide concentration exceeds a room's setpoints by more than 10% for 10 minutes
- .7 On a high-pressure drop at the filters, alarm to the OWS. Set point to be field determined and adjustable at OWS.
- .8 System to operate in standby power operation and be monitored by the EMCS.

3.25 SOP - FANCOIL UNIT WITH DOAS CONNECTION, LABORATORY SPACES

- .1 The fancoil unit is to provide heat and cooling for the space(s) it serves and O/A based on E/A requirements.
 - .1 Applicable fancoil units: FCU-12 to FCU-20
- .2 A combination space thermostat and CO2 sensor to be installed in each space at the location indicate on the plans and will provide heating/cooling control and CO2 level indication for the space.
- .3 During occupied periods:
 - .1 Fancoil fan to operate continuously at 100% speed and the O/A inlet damper to modulate to the space's maximum O/A setpoint.
 - .2 On call for heating, heating control valve to modulate to maintain space heating setpoint.
 - .3 On call for cooling, cooling control valve to modulate to maintain space cooling setpoint.
- .4 During unoccupied periods:
 - .1 Fancoil fan to operate continuously at 30% speed and the O/A inlet damper to modulate to the space's minimum O/A setpoint.
 - .2 On call for heating, heating control valve to modulate to maintain space heating setpoint.
 - .3 On call for cooling, cooling control valve to modulate to maintain space cooling setpoint.
- .5 Setpoints
 - .1 Heating = 18°C
 - .2 Cooling = 23°C
 - .3 CO2 level = 800 ppm
- .6 Alarm at OWS if carbon dioxide concentration exceeds a room's setpoints by more than 10% for 10 minutes
- .7 On a high-pressure drop at the filters, alarm to the OWS. Set point to be field determined and adjustable at OWS.
- .8 System to operate in standby power operation and be monitored by the EMCS.

3.26 SOP - FANCOIL UNIT WITH CVR O/A CONNECTION OR WITH NO O/A CONNECTION

- .1 The fancoil unit is to provide heat and cooling for the space(s) it serves.
 - .1 Applicable fancoil units:
 - .1 FCU-22, SB1050 - Student & Staff Work Zone and SB1042 - Student & Staff Work Zone
 - .2 FCU-23, SB1033 - Student & Staff Work Zone
 - .3 FCU-24, SB1H005 - Corridor
 - .4 FCU-28, SB1030 - Main Electrical Room and P1030A - Emergency Distribution Room
 - .5 FCU-29, SB1057 - Network & Security Room
 - .6 FCU-32, SB1H007 - Corridor
 - .7 FCU-33, SB1H008 - Corridor and SB1033 - Student & Staff Work Zone
 - .2 Space thermostat to cycle fancoil fan and heating or cooling control valve to satisfy setpoint.
 - .1 Initial heating setpoint = 18°C
 - .2 Initial cooling setpoint = 23°C
 - .3 On a high-pressure drop at the filters, alarm to the OWS. Set point to be field determined and adjustable at OWS.
 - .4 System to operate in standby power operation and be monitored by the EMCS.

3.27 SOP - UNIT & CABINET UNIT HEATER CONTROL

- .1 Thermostat to cycle CUH/UH fan motor to satisfy set point.
 - .1 Initial setpoint, unit heaters = 18°C
 - .2 Initial setpoint, cabinet unit heaters = 16°C
- .2 Where control valve indicated on drawings to be provided for CUH/UH, thermostat to also cycle HW control valve
- .3 Systems to operate in standby power operation.

3.28 SOP - HEATING CONVECTOR CONTROL

- .1 Thermostat to cycle convector control valve to satisfy set point.
 - .1 Initial setpoint = 18°C
- .2 Systems to operate in standby power operation.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS & SUMMARY

- .1 The General Conditions, Supplements and Amendments shall govern this Section (read in conjunction with Instructions to Tenderers / Bidders). This section covers items common to all Electrical sections and is intended only to supplement the requirements of Division 01.
- .2 Reference to "Electrical Divisions" shall mean all sections of Divisions 26, 27, 28, 33, 34 & 48 in the Master Format or the Canadian Master Specifications.
- .3 The word "Provide" shall mean "Supply and Install" the products and services specified. "As Indicated" means that the item(s) specified are shown on the drawings.
- .4 Provide materials, equipment and plant, of specified design, performance and quality; and, current models with published certified ratings for which replacement parts are readily available. Provide project management and on-site supervision to undertake administration, meet schedules, ensure timely performance, ensure coordination, and establish orderly completion and the delivery of a fully commissioned installation.
- .5 The most stringent requirements of this and other electrical sections shall govern.
- .6 All work shall be in accordance with the PROJECT Drawings and Specifications and their intent, complete with all necessary components, including those not normally shown or specified, but required for a complete installation.
- .7 Provide seismic restraints for all required equipment and wiring systems.
- .8 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start-up and test. Include all field assembly of loosely/separately packaged accessories
- .9 "Consultant" shall mean Stantec Consulting Ltd.

1.2 REFERENCES

- .1 Install in accordance with CSA C22.1 (current adopted edition) - except where specified otherwise.
- .2 Install in accordance with Government of Yukon Design Requirements and Technical Standards (current adopted edition) – except where specified otherwise.
- .3 Refer to CSA C22.1 Appendix A "Safety Standards for Electrical Equipment" for applicable codes and the related revisions
- .4 Refer to CSA C22.1 for related 'Reference Publications'
- .5 Refer to NBCC Table 1.3.1.2 for applicable codes and the related revisions.
- .6 Comply with Local Electrical Bulletins and by-laws relating to the Authority having Jurisdiction.
- .7 Install overhead and underground systems in accordance with CSA C22.3 No.1 (current adopted edition) - except where specified otherwise.
- .8 Preferred Voltage Levels for AC Systems, 0-50,000V in accordance with CAN3-C235 (current adopted edition)

1.3 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.4 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235- current edition
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.5 SUBMITTALS

- .1 Submittals to be in accordance with Division 01.
- .2 Product Data: submit WHMIS MSDS in accordance with Division 01 - Sustainable Requirements and Division 02- Hazardous Materials
- .3 Single Line Diagram. Provide single line electrical diagrams under plexiglass as follows:
 - .1 Submit full size plot for review prior to installing:
 - .2 Electrical distribution system: locate in main electrical room.
 - .3 Electrical power generation and distribution systems: locate in power plant rooms.
- .4 Shop Drawings:
 - .1 Submit shop drawings, product data and samples in accordance with Division 01. The submission shall be reviewed, signed, and processed as described in Division 01.
 - .2 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
 - .3 Where applicable, include wiring, line, and schematic diagrams. Include wiring drawings or diagrams showing interconnection with work of other Sections.
 - .4 Content
 - .1 Shop drawings submitted title sheet.
 - .2 Data shall be specific and technical.
 - .3 Identify each piece of equipment.
 - .4 Information shall include all scheduled data.
 - .5 Advertising literature will be rejected.
 - .6 The project and equipment designations shall be identified on each document.
 - .7 Information shall be given in S.I. units
 - .8 The shop drawings/product data shall include:
 - .1 Dimensioned construction drawings with plans and sections showing size, arrangement, and necessary clearances, with all equipment weights and mounting point loads.
 - .2 Mounting arrangements.
 - .3 Detailed drawings of bases, supports and anchor bolts.
 - .4 Control explanation and internal wiring diagrams for packaged equipment.
 - .5 A written description of control sequences relating to the schematic diagrams.

- .5 Format
 - .1 Black line prints 216 mm x 280 mm [8-1/2" x 11"] or 280 mm x 430 mm [11" x 17"].
 - .2 Larger drawings may be submitted on reproducible single sheet media (ie not bound) with space for stamps and signatures - master set plus one working copy.
 - .3 Bill of Quantities for related components, identified by model number, listed on the front cover with item identification numbers.
- .6 No. of copies
 - .1 Provide number of copies indicated in Section Division 01 with a minimum of 2 copies to be retained by the Consultant.
- .7 Coordination
 - .1 Where electrical equipment requires support or backing by other trades or mechanical connections, the shop drawings shall also be circulated through the other "services" contractor(s) prior to submission to the Consultants.
- .8 Keep one [1] copy of shop drawings and product data, on site, available for reference.
- .9 Quality Control: in accordance with Division 01 - Quality Control
 - .1 Provide CSA certified equipment and material. Where CSA certified equipment and/or material is not available, submit such equipment and/or material to the authority having jurisdiction for special approval before delivery to site.
 - .2 Submit test results of installed electrical systems and instrumentation.
 - .3 Submit, upon completion of Work, the electrical "load balance" report.
- .10 Permits and Fees:
 - .1 Submit to Electrical Inspection Department, Local Fire Authorities and Supply Authority the necessary number of drawings and specifications for examination and approval prior to commencement of work. Obtain all required permits and pay all fees.
 - .2 Arrange for inspection of all Work by the authorities having jurisdiction. On completion of the Work, furnish final unconditional certificates of approval by the inspecting authorities.

1.6 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Division 01 - Quality Control
- .2 Qualifications: electrical work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial and/or Territorial Act respecting manpower vocational training and qualification.
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

- .3 Site Meetings: in accordance with Division 01 - Construction Progress Schedule
 - .1 Site Meetings: as part of Manufacturer's Field Services: schedule site visits, to review Work, at stages listed below:
 - .1 At time of initial shop drawing submission to confirm any existing conditions and to coordinate with the project schedule and any cross discipline requirements.
 - .2 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
 - .3 During progress of Work at key schedule points as determined.
 - .4 At commissioning.
 - .5 Upon completion of Work, after cleaning is carried out.
 - .4 Health and Safety Requirements: do construction occupational health and safety in accordance with Division 01 - Health and Safety Requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Material Delivery Schedule: provide Consultant with schedule within 4 weeks after award of Contract.
- .2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and/or recycling in accordance with Division 01 Construction/Demolition Waste Management and Disposal.

1.8 SYSTEM START-UP

- .1 Refer to Division 01, and as follows.
- .2 Instruct Consultant and operating personnel in the operation, care and maintenance of equipment.
- .3 Arrange and pay for services of manufacturer's factory service Engineer to supervise start-up of installation, check, adjust, balance and calibrate components, where required in these specifications.
- .4 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

1.9 OPERATING INSTRUCTIONS

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .3 Safety precautions.
 - .4 Procedures to be followed in event of equipment failure.
 - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
- .4 Post instructions where directed.

- .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.10 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 - Construction/Demolition Waste Management and Disposal and with the Waste Reduction Work plan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.11 ASBESTOS REMOVAL

- .1 Refer to specification Division 01 for procedures, removal and disposal of asbestos.
- .2 If during renovations / demolition, asbestos is discovered (or material suspected to be asbestos), all work in that area shall immediately cease and the General Contractor advised. The General Contractor shall take immediate appropriate action to verify presence of friable asbestos and be responsible for the removal of all friable asbestos.
- .3 This division will not be entitled to a claim for any delays resulting from the investigation of or removal of asbestos.

1.12 DRAWINGS AND MEASUREMENTS

- .1 Drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of work and are not detailed installation drawings. Do not scale the drawings. Obtain accurate dimensions from the Architectural and Structural drawings.
- .2 Consult the architectural drawings and details for exact locations of fixtures and equipment. Obtain this information from the Consultant where definite locations are not indicated.
- .3 Take field measurements, where equipment and material dimensions are dependent upon building dimensions.
- .4 Where imperial units have been indicated in brackets [] following the requirements in SI units, the conversion is approximate and provided for convenience. The SI units shall govern.

1.13 PROJECT COORDINATION

- .1 Check drawings of all trades to verify space and headroom limitations for work to be installed. Coordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent involving extra cost to the Owner, without the Consultant's written approval.
- .2 The drawings indicate the general location and route to be followed by the electrical services. Where details are not shown on the drawings or only shown diagrammatically, the services shall be installed in such a way as to conserve head room and interfere as little as possible with the free use of space through which they pass. Service lines shall run parallel to building lines. All services in the ceiling shall be kept as tight as possible to beams or other limiting members at high level. All electrical services shall be coordinated in elevation to ensure that they are concealed in the ceiling or structural space provided unless detailed otherwise on drawings.
- .3 Work out jointly all interference problems on the site and coordinate all work before fabricating, or installing any material or equipment. Where necessary, produce interference/coordination drawings showing exact locations of electrical systems or

equipment within service areas, shafts and the ceiling space. Distribute copies of the final interference/coordination drawings to the Architect and Consultant and all affected parties.

- .4 Ensure that all materials and equipment fit into the allotted spaces and that all equipment can be properly serviced and replaced, if and when required. Advise the Consultant of space problems before installing any material or equipment. Demonstrate to the Consultant on completion of the work that all equipment installed can be properly, safely serviced and replaced, if and when required.

1.14 PROVISION FOR FUTURE EQUIPMENT AND CONSTRUCTION

- .1 Leave clear spaces designated for future equipment or building expansion where indicated. Plan for the installation under this contract and ensure clear accessible, unhindered access to the space is allowed for.
- .2 Where contract documents don't clearly indicate the future expansion requirements, but known services are required, provide written "request for information" to the consultant before making assumptions as to intent.

1.15 SPRINKLER PROOF REQUIREMENTS

- .1 All equipment and wiring systems shall be sprinklerproof standard where sprinkler fire protection systems are installed.
- .2 In rooms where electrical equipment is installed surface mounted, electrical equipment contained in these rooms to be protected to inhibit water ingress into electrical equipment. Exposed conduits connected to equipment to utilize watertight connectors. Top entry to be avoided where possible.
- .3 Electrical equipment including transformers, switchgear, motor control, and panelboards shall be certified 'sprinkler proof' design.

1.16 EQUIPMENT RESTRAINT

- .1 Related Section: 26 05 05 Seismic Restraint.
- .2 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

1.17 REUSED EQUIPMENT

- .1 Where existing equipment is being relocated and re-used, check and report on the condition to the Consultant before reinstallation. Protect and carefully store equipment designated for reuse.

1.18 SEQUENCE OF WORK

- .1 Before interrupting major services notify the Owner well in advance and arrange an acceptable schedule for the interruptions.
- .2 Before interrupting any services complete all preparatory work as far as reasonably possible and have all necessary materials on site and prefabricated (where practical) and work continuously to keep the length of interruption to a minimum.
- .3 Include for the cost of all work that may be required out of regular hours to minimize the period of service interruption when modifying the existing systems.
- .4 All trades in this Division shall make allowance for the implications of having to totally complete all work in the new addition before proceeding with work in the existing building.

1.19 BUILDING OPERATION DURING CONSTRUCTION

- .1 In order to minimize operational difficulties for the existing building staff, the various trades must cooperate with the owner throughout the entire construction period and

particularly ensure that noise is minimized.

- .2 Convenient access for the staff and public to the building must be maintained at all times. Minor inconvenience and interruption of services will be tolerated, provided advance notice is given, but the Contractor will be expected to coordinate his work, in consultation with the owner, so the operation of the facility can be maintained as nearly normal as possible.

1.20 EXISTING SERVICES

- .1 Protect all existing services encountered. Every effort has been made to show the known existing services. However, the removal of concealing surfaces may reveal other existing services. Work with the Owner's staff to trace the originating source and points served. Obtain instructions from the Consultant when existing services require relocation or modifications, other than those already indicated in the Contract Documents.
- .2 Arrange work to avoid shutdowns of existing services. Where shutdowns are unavoidable, obtain the Owner's approval of the timing, and work to minimize any interruptions.
- .3 Shutdowns, to permit connections, to be coordinated with the maintenance staff.
- .4 In order to maintain existing services in operation, temporary relocations and wiring may be required.
- .5 Be responsible for any damages to existing systems by this work.
- .6 The interruption of utility services to permit tie-ins shall be arranged through the owner's representative. Application must be received in writing at least seven (7) calendar days prior to the date required for the shutdown. Service shutdowns shall only be carried out by Physical Plant and will normally be scheduled to occur during evenings or weekends. The Owner reserves the right to withhold permission for a reasonable period with respect to any shutdown, if the shutting-off of a service interferes with essential building operations.

1.21 SALVAGE

- .1 All conduit, wiring and equipment which becomes redundant and is no longer required due to the work in this Contract shall be completely removed.
- .2 All existing items which need to be removed, and which have a reasonable salvage value, shall be carefully removed and handed over to the Owner. Handing over to the Owner includes moving to Owner's designated storage place on site. These items shall not become the property of the Contractor. Obtain a written receipt from the Owner detailing each of the items handed over.
- .3 Remove all redundant material not required by the Owner from the site.

1.22 WARRANTY

- .1 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the Division 01.
- .2 Take note of any extended warranties specified.
- .3 Furnish a written warranty stating that all work executed under this Division will be free from defects of material and workmanship for a period of one (1) year from the date of substantial performance.
- .4 Promptly investigate any electrical or control malfunction, and repair or replace all such defective work and all other damages thereby which becomes defective during the time of the warranty.

1.23 TENDER INQUIRIES

- .1 All contractor queries during the tender period shall be made in writing to the consultant. Contractor queries will be collected and suitable addenda will be issued for clarification. No verbal information will be considered valid or issued by the consultant's office during tender. All tender queries may be faxed, mailed or couriered to the consultant's office. No telephone questions will be answered.

1.24 EXAMINATION

- .1 Visit the site before preparing the tender and examine all existing conditions. No extra cost will be considered for any misunderstanding of work to be done resulting from failure to visit the site.
- .2 Examine the documents for details of work included. Obtain a written clarification in the event of conflict within the specification, between the specification and the drawing, or in the drawing. Obtain written clarification from the Consultant if work affecting the installation is not clear. Where this is not done in advance, allow in the tender sum for providing the more costly alternative.

1.25 RESPONSIBILITIES

- .1 Ensure that equipment does not transmit noise and/or vibration to other parts of the building, as a result of poor installation practice.
- .2 Where the Contract Documents do not contain sufficient information for the proper selection of equipment for bidding, notify the Consultant during the tendering period. If clarification is not obtainable, allow for the most expensive arrangement. Failure to do this shall not relieve the Contractor of responsibility to provide the intended equipment.
- .3 Protect equipment and material from the weather, moisture, dust and physical damage.
- .4 Cover equipment openings and open ends of conduit, piping and pullboxes as work progresses. Failure to do so will result in the Trade being required to adequately clean or replace materials and equipment at no extra cost to the Owner.
- .5 Protect all existing services encountered. Obtain instructions from the Engineer when existing services require relocation or modification.
- .6 Refinish damaged or marred factory finish to factory finish.
- .7 The specifications and drawings form an integral part of the Contract Documents. Neither the drawings nor the specifications shall be used alone. Work omitted from the drawings but mentioned or reasonably implied in the specifications, vice versa, shall be considered as properly and sufficiently specified and shall be provided. Misinterpretation of any requirement of either plans or specifications shall not relieve this Contractor of the responsibility of properly completing his trade to the approval of the Consultant.

1.26 STANDARD OF ACCEPTANCE

- .1 Standard of Acceptance means that the item named and specified by manufacturer and/or catalogue number forms part of specification and sets standard regarding performance, quality of material and workmanship and when used in conjunction with a referenced standard, shall be deemed to supplement the standard.
- .2 Where two or more manufacturers are listed, the manufacturer's name shown first or underlined or shown with a model name and/or number was used in preparing the base design. Tenders may be based on any one of those named, provided that they meet every aspect of the base design and every aspect of the drawings and specifications.
- .3 Where other than the first named or the underlined manufacturer or scheduled/specified manufacturer is selected or approved, include for the cost of any resulting work (both under this Division and other Divisions) and any necessary redesign of installation or structure. Submit redesign drawings for review with Shop Drawings. Maintain installation, access and servicing clearances. Equipment/materials shall not exceed the

available space limitations. Redesign drawings shall be to scale and of a standard equal to the Project Drawings.

- .4 A visible manufacturer's nameplate shall indicate manufacturer's name, model number, serial number, capacity data, electrical characteristics and approval stamps.

1.27 ADDITION OF ACCEPTABLE MANUFACTURERS

- .1 Material/products considered to satisfy the specification, but of a manufacturer other than those named may be submitted to the Consultant for consideration not later than five (5) working days prior to closing of tender or of bid depository subtrade tender whichever is earlier.
- .2 Alternate approvals will be given by written addendum only. No other substitution will be permitted after closing of tenders.
- .3 Alternate approvals granted before the closing of tenders will be limited to a manufacturer's system and/or series only. This limited approval will not preclude substitute equipment/material from complying with specific features included with equipment/material specified. Determine that the alternate product meets the specification intent before basing a tender on the product
- .4 Where alternate equipment/materials are selected, allow for effects on other parts of the work of this Trade and other Trades. Where substantial changes in arrangement are required, submit shop drawings of the proposed changes with Plan and Section views and show effects on work of other Trades. Alternate equipment/materials shall not exceed the available space limitations. Maintain installation, access and servicing clearances. No extra will be allowed due to the use of alternate equipment/materials.
- .5 Where two or more items of equipment and/or material, of the same type, are required, provide products of a single manufacturer.
- .6 Install and test all equipment and material, in accordance with the detailed recommendations of the manufacturer.

1.28 EQUIPMENT LIST

- .1 Submit a completed Equipment List, showing the make of equipment and material included in the Tender, including the names of the subtrades, 10 days after the award of the Contract. **Form EF110** in Appendix A shall be used for this purpose.
- .2 The equipment list shall be a full list of materials or systems intended for installation.

1.29 PROGRESS CLAIM AND CHANGEORDER BREAKDOWNS

- .1 Ten (10) days after the award of contract, submit price breakdowns on photocopies of the Price Breakdown **Form EF112** included in Appendix A.
- .2 In particular cases more detail may be necessary to properly assess a change order or progress claims. This additional information could include all suppliers and all sub-contractors when requested by the Consultant. Provide details for each section of the electrical work listed when requested.
- .3 Mark-up information is required for change orders but is optional on the original tender price.
- .4 Progress claims will not be certified nor payment made beyond 90% of the overall Electrical contract until commissioning and verification of the systems are complete. This procedure is to allow for any necessary deficiency holdbacks on items which do not become apparent until the systems are commissioned.

1.30 PROJECT CLOSE-OUT REQUIREMENTS

- .1 Refer to detailed specifications in each section for detailed requirements. Also refer to

Specification Appendix A Form EF-142 for list of required substantial completion submissions. Record drawings to be submitted to Consultant and all life safety systems must be operational, verified and tested and demonstrated to Consultant prior to issuance of Schedule C.

1.31 SUBSTANTIAL PERFORMANCE REQUIREMENTS

- .1 Before the Consultant is requested to make an inspection for substantial performance of the work:
 - .1 Commission all systems and prove out all components, interlocks and safety devices.
 - .2 Submit a letter certifying that all work is complete for the intended use, operational, clean and all required submissions have been completed. **Form EF143** in Appendix A should be used for this purpose.
 - .3 A complete list of incomplete or deficient items shall be provided. If, in the opinion of the Consultant, this list indicates the project is excessively incomplete, a substantial completion inspection will not be performed.
- .2 The work will not be considered to be ready for use or substantially complete until the following requirements have been met:
 - .1 All reported deficiencies have been corrected.
 - .2 Operating and Maintenance Manuals completed.
 - .3 "As Built" Record Drawing ready for review.
 - .4 Systems Commissioning has been completed and has been verified by Consultant.
 - .5 All demonstrations to the owner have been completed.
 - .6 All documents required on **Form EF142** in Appendix A have been submitted.
- .3 Consultants Letters of Assurance will not be issued until the following requirements have been met:
 - .1 All items listed in .1 above have been completed or addressed.
 - .2 Certificate of Penetrations through separations (**Form EF130**).
 - .3 Provincial or City Electrical Inspection - Certificate of inspection.
 - .4 Seismic Engineers letter of Assurance and final inspection report.
 - .5 Certificate of Substantial Performance (**Form EF143**).
 - .6 Signed off copy of Consultants final inspection report.
 - .7 Fire alarm verification.

1.32 DEFICIENCY HOLDBACKS AND DEFICIENCY INSPECTIONS

- .1 Work under this Division which is still outstanding when substantial performance is certified will be considered deficient and a sum equal to at least twice the estimated cost of completing that work will be held back.
- .2 It is expected that outstanding work will be completed in an expeditious manner and the entire holdback sum will be retained until the requirements for Total Performance of Division 26, 27, 28, 33 (electrical) work have been met and verified.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Division 01 - Sustainable Requirements:

Construction

- .2 Do verification requirements in accordance with Division 01 Sustainable Requirements: Contractor's Verification.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide materials and equipment in accordance with Division 01 and as follows.
- .2 Material and equipment to be CSA certified. Where CSA certified material or equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval.
- .3 Where equipment or materials are specified by technical description only, they are to be of the best commercial quality available for the intended purpose.
- .4 Factory assemble control panels and component assemblies.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Provide all power and control wiring, conduit, wire, fittings, disconnect switches, motor starters, for all mechanical equipment unless otherwise specified.
- .2 Ground all motors to conduit system with separate grounding conductor in flexible conduit or bonding conductor in the flexible conduit.
- .3 Connections shall be made with watertight flexible conduit with watertight connectors.
- .4 Control wiring and conduit standards are specified in the Electrical Divisions. Refer to Mechanical Divisions for scope of work and particular details.

2.4 WARNING SIGNS

- .1 Provide warning signs, as specified or to meet the requirements of Inspection Department, Authority having Jurisdiction, Engineer and Architect.
- .2 Use decal signs, minimum 175 x 250 mm [7" x 10"] size

2.5 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

2.6 EQUIPMENT IDENTIFICATION

- .1 Identify all electrical equipment including but not limited to starters, disconnects, remote ballasts and controls with nameplates and labels.
- .2 Refer to Government of Yukon Design Requirements and Technical standards, Section 6.1.4 – Identification, for equipment labelling and colour identification requirements.

2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.8 CONDUIT, CABLE AND PULLBOX IDENTIFICATION

- .1 Colour code conduits, metallic sheathed cables, pullboxes and junction boxes.
- .2 Refer to Government of Yukon Design Requirements and Technical standards, Section 6.1.4 – Identification, for conduit colour and labelling identification requirements.
- .3 Colour coding to be as follows unless otherwise specified by the Owner:

SYSTEM	MAJOR BAND	MINOR BAND	CHARACTERS
347/600V Normal	Beige		
347/600V Emergency	Beige	Red	
347/600V UPS	Dark Blue	Orange	
277/480V	Yellow	Green	
120/208V Normal	Grey		
120/208V Emergency	Grey	Red	
120/208V UPS	Light Blue	Orange	
Ground	Dark Green		GR
Fire Alarm	Red		FA
Emg Voice Paging	Red	Dark Green	EP
Fire Fighters Telephone	Red	Light Green	FFT
Computer/Data	Light Green		COM
Telephone	Light Green	Black	TEL
General Intercom	Light Green	Yellow	IC
Low Level Paging	Light Green	White	PA
Commercial TV	Dark Brown		TV
AV/TV Systems	Light Brown		AV/TV
Security Systems	Purple		SEC
Building Alarm	Purple	White	BA
CCTV	Purple	Yellow	CCTV
Door Intercom	Purple	White	DI
Door Lock Release	Purple	Black	ED
Master Clock System	Yellow		CS
BAS (Digital)	White	Green	BCD
BAS (110V)	White	Black	BCH
BAS (LV)	White	Blue	BCL
PLC (Digital)	White	Brown	PLC
Low Voltage Control	White	Yellow	LVC

- .4 Shop finish metal enclosure surfaces by removal of rust and scale, cleaning, application of rust resistant primer inside and outside and at least two coats of finish enamel.
- .5 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original finish.
- .6 Clean and prime paint exposed hangers, racks, fastenings to prevent rusting. Finish painting shall be provided by Division 09.
- .7 Paint outdoor electrical equipment "equipment green" finish.
- .8 Paint indoor switchgear and distribution enclosures light gray unless otherwise indicated in particular specification sections for specialised or emergency power equipment.

2.9 ACCESS PANELS (DOORS)

- .1 Unless otherwise noted, access doors shall be minimum: 450mmx450mm [18"x18"] for body entry; 300mmx300mm [12"x 12"] for hand entry.
- .2 Access doors in fire separations of 3/4 hour rating, and higher, and firewalls shall have a compatible fire rating and a ULC label with tamper-proof latch, self closing.
- .3 Minimum Requirements:
 - .1 180 degree door swing, mitred rounded safety corners flush welded, concealed hinges, screwdriver latches, and anchor straps or lugs to suit construction, all steel prime coated.
 - .2 Plaster or wet wall construction: 14 gauge bonderized steel flush with wall or ceiling type with concealed flange.
 - .1 Acceptable Product: Acudor PS-5030.
 - .3 Masonry or drywall construction: 16 gauge for 400 mm [16"] x 400 mm [16"] and smaller, 14 gauge for 450 mm [18"] x 450 mm [18"] and larger bonderized steel face of wall type with exposed flange.
 - .1 Acceptable Product: Acudor UF-5000.
 - .4 Tile, ceramic tile, marble, terrazzo, plaster or wet wall construction in washrooms and other special areas: 14 gauge stainless steel flush with wall or ceiling type with concealed flange.
 - .1 Acceptable Product: Acudor PS-5030 stainless.
 - .5 Acoustical tile ceiling and similar block materials: 14 gauge bonderized steel recessed ceiling type.
 - .1 Acceptable Product: Acudor AP-5010 or AT-5020.
 - .6 Feature wall construction: Recessed wall type that is selected to complement and conform to the architectural module, treatment, or panelling. The size shall conform to adjacent finishes.
 - .7 Access panels in fire separations and fire walls shall have a compatible fire rating and ULC label. (ie. Acudor Fire Rated FW-5050 or FB-5060).
- .4 Standard of Acceptance : Zurn, Wade, Acudor, Can-Aqua, Milcor, Maxam, Van-Met.

2.10 ANCHOR BOLTS AND TEMPLATES

- .1 Supply anchor bolts and templates for installation by other Divisions.

2.11 FASTENING TO BUILDING STRUCTURE

- .1 General:
 - .1 Do not use inserts in base material with a compressive strength less than 13.79 MPa [2000 psi] [refer to structural drawings].
 - .2 All inserts supporting conduit racks shall have a factor of safety of 5. All other inserts shall have a factor of safety of 4.
- .2 Types:
 - .1 Cast-in-place type:
 - .1 Channel type - Burndy, Canadian Strut, Unistrut, Cantruss or Hilti Channel.
 - .2 Wedge type galvanized steel concrete insert, Grinnell Fig. 281 for up to 200 mm [8"] pipe size.

- .3 Universal type malleable iron body insert, Grinnell Fig. 282 for up to 200 mm [8"] pipe size.
- .2 Drilled, mechanical expansion type:
 - .1 Hilti HSL or UCAN LHL heavy duty anchor for use in concrete with compressive strength not less than 19.6 MPa [2840 psi].
 - .2 Hilti Kwik-Bolt or UCAN WED stud anchor for concrete. (Do not use in seismic restraint applications).
 - .3 Hilti HDI or UCAN IPA drop-in anchor for concrete.
 - .4 Hilti or UCAN Sleeve Anchor (medium and light duty) for concrete and masonry.
 - .5 Hilti ZBP or UCAN Zamac pin bolt (light duty) for concrete and masonry.
- .3 Drilled, adhesive type:
 - .1 Hilti HVA or UCAN Adhesive Anchor consisting of anchor rod assembly with a capsule containing a two-component adhesive, resin and hardener.
 - .2 Hilti HY150 consisting of anchor rod with a 2 part adhesive system.
 - .3 For use in concrete housekeeping bases (in vertical downward position) where the distance to the edge of the concrete base could cause weakness if a mechanical expansion type anchor were used.
 - .4 Rod assemblies shall extend a minimum of 50 mm [2"] into the concrete slab below the housekeeping bases.
- .3 Note:
 - .1 All drilling for inserts shall be performed using the appropriate tool specifically designed for the particular insert. The diameter and depth of each drilled hole shall be to the exact dimensions as specified by the insert manufacturer.
 - .2 Refer to manufacturer's recommendations for tightening torques to be applied to inserts.
 - .3 Where specifically called for, drills shall include a dust vacuum system, Hilti SAV Dust Vacuum System.

2.12 EQUIPMENT SUPPORTS

- .1 Provide stands and supports for equipment and materials supplied.
- .2 Lay out concrete bases and curbs required under Electrical Divisions. Coordinate with Concrete Divisions.
- .3 Concrete bases shall be a minimum of 100 mm [4"] thick, or as noted and shall project at least 150 mm [6"] outside the equipment base, unless otherwise directed. Bases and curbs shall be keyed to the floor and incorporate reinforcing bars and/or steel mesh. Chamfer edges of bases at 45 degrees.
- .4 Equipment with bedplates shall have metal wedges placed under the edges of the bedplates to raise them 25mm [1"] above the base after levelling. The wedges shall be left permanently in place. Fill the space between the bedplate and the base with non-shrink grout - Embeco or In-Pakt.
- .5 Construct equipment supports of structural steel. Securely brace. Employ only welded construction. Bolt mounting plates to the structure.
- .6 Support ceiling hung equipment with rod hangers and/or structural steel.

2.13 MISCELLANEOUS METAL

- .1 Be responsible for all miscellaneous steel work relative to Electrical Divisions of the Specifications, including but not limited to:
 - .1 Support of equipment.
 - .2 Hanging, support, anchoring, guiding and relative work as it applies to wiring raceways and electrical equipment.
 - .3 Earthquake restraint devices - refer also to "Seismic Restraint" sections
 - .4 Bridle rings - secure to structure or steel supports.
- .2 All steel work shall be prime and undercoat painted ready for finish under the related Division.

2.14 MAINTENANCE MATERIALS AND CABINET

- .1 Provide maintenance materials in accordance with Division 01 and specified in appropriate Sections.
- .2 Refer to Specification Appendix A Electrical **Form EF140** "Items to be handed to the Owner". Obtain the Building Owners representative sign off. Use **Form EF 140** for this purpose.
- .3 Provide a finished painted sheet steel "spare equipment cabinet". Cabinet to have a continuous hinge and complete with shelves and hasp to suit padlock. Minimum size 600 [24"] x 900 [36"] x 200 [8"] deep. Mount on wall in the Electrical Room. Provide a plastic covered typewritten list of spare parts and affix to the inside of the door.

2.15 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into maintenance manual specified in Section 26 05 03, and as follows.
- .2 Include in operations and maintenance data:
 - .1 Details of design elements, construction features, component function and maintenance requirements, to permit effective operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.
 - .2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.
 - .3 Wiring and schematic diagrams.
 - .4 Names and addresses of local suppliers for items included in maintenance manuals.
- .3 Include in the manual the following major sections:
 - .1 Title page (in plastic cover).
 - .2 Comprehensive description of the operation of the systems, including the function of each item of equipment within the system.
 - .3 Detailed instructions for the normal maintenance of all systems and equipment installed including procedures and frequency of operational checks and service and troubleshooting instructions.
 - .4 Local source of supply for each item of equipment.
 - .5 Wiring and control diagrams.
 - .6 Spare parts list.

- .7 Copies of guarantees and certificates.
- .8 Manufacturer's maintenance brochures and shop drawings.
- .4 The manual information shall be bound in a three "D-ring" hard back reinforced vinyl covered ("bar lock" post type where more than 50mm [2"] rings required) binder c/w index tab separators to divide the different sections. The binder cover shall be black with white lettering. Printing of the binder cover shall be completed before the binder is manufactured and the wording shall be approved by the Consultant before printing.
- .5 Submit a draft copy to the Consultant for review thirty (30) days prior to start up of the systems and equipment.
- .6 Submit three (3) copies in the final approved form.

2.16 PROJECT RECORD DRAWINGS

- .1 Provide project record documents as specified in Division 01 as further called for in this Division.
- .2 During the construction period, keep on Site a clean set of drawings marked up to reflect the "As-Built" state, for examination by the Consultant on a regular basis. Include elevations and detailed locations of buried services, empty conduit systems and junction and pull boxes.
- .3 The Electrical Division shall include all associated costs to obtain and complete the Record Drawings in REVIT 2018, including retaining the services of an approved party to transfer all changes to amend the REVIT model. Include all revisions and change orders.
- .4 Submit the "Record Drawing" REVIT 2018 files and one PDF copy of the drawings to the consultant prior to Total Performance of the contract.
- .5 Note: The Contractor will be required to sign a standard Stantec / Contractor agreement entitled "Authorization to Use REVIT files". The agreement restricts the use of the files for the purpose of "as-built" only.

Part 3 Execution

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

- .1 Ensure manufacturers nameplates and CSA labels to be visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit and protruding 50 mm [2"].
- .2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .3 Install roof jacks where conduit and cables penetrate roofs. Apply sealant after installation.
- .4 All cables and conduits to be installed concealed in finished areas.

3.4 LOCATION OF OUTLETS

- .1 Do not install outlets back-to-back or in the same stud space in wall; allow minimum 400mm [16"] horizontal clearance between boxes.
- .2 Change location of outlets at no extra cost or credit, providing distance does not exceed

3000mm [10'- 0"] and information is given before installation.

- .3 Locate light switches on strike side of doors unless otherwise indicated.
- .4 Locate light switches on latch side of doors.
- .5 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not indicated verify before proceeding with installation. Confirm the height of devices in handicapped facilities before installation.
- .3 Refer to detail on drawings.
- .4 In the absence of a drawing detail or drawing note, use the following:

Device	Height	Comment
Local switches	1150 [46"]	Includes LV switches, line switches, dimmers, etc.
Wall receptacles/data	450 [18"]	General
Wall receptacles/data	200 [8"]	Above top of continuous baseboard heater
Wall receptacles/data	175 [7"]	Above top of counters or counter splash backs – coordinate with Architectural detail
Wall receptacles/data	900 [36"]	In mechanical rooms
Panelboards	1800 to top [72"]	To top of enclosure (standard enclosure)
Card Readers	1150 [46"]	
Fire alarm manual stations	1150 [46"]	ULC S524-14 requires 1050mm – 1150mm to the centre of the device.
Fire alarm bells/audio	2300 [92"]	ULC S524-14 requires not less than 2300mm to centre. In any event not closer than 150mm to the ceiling from the top of the device.
Fire alarm visual devices	2000 [80"]	ULC S524-14 requires not less than 2000mm and not more than 2400mm to centre.
Fire alarm Annunciator	1800 Top [72"]	ULC S524 requires not more than 1800mm above finished floor.
End of line resistors	1500 [60"]	
Television outlets		As receptacles –coordinate with equipment location
Wall mounted speakers & clocks	1980 [78"]	Coordinate with equipment location
Door bell pushbuttons	1150 [46"]	Coordinate with door location
Emergency Lighting (wall mounted)		150mm below ceiling or 4800mm max.

3.6 COORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to the required values and settings to provide a fully coordinated system.

3.7 FIELD QUALITY CONTROL

- .1 Load and Balance:
 - .1 Measure voltage and phase & neutral currents to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase and neutral currents to dry-core transformers and motor control centres, operating under normal load,
 - .3 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .2 Conduct and pay for the following tests:
 - .1 Power generation and distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.

- .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .5 Systems: fire alarm system and communications.
- .6 Main ground resistance (at all grounding locations).
- .7 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
- .3 Provide Consultant with at least one weeks notice prior to testing.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports.
 - .2 Furnish manufacturer's certificate or letter conforming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
 - .3 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .4 Schedule site visits to review Work.
- .6 Reports:
 - .1 Provide written reports in a timely manner upon completion of the testing and load balance. Indicate test hour and date.

3.8 CLEANING

- .1 Do final cleaning in accordance with Division 01.
- .2 At time of final cleaning, clean lighting reflectors, lenses and other lighting surfaces that have been exposed to construction dust and dirt.
- .3 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .4 Clean and prime paint exposed non-galvanised hangers, racks, fastenings to prevent rusting. Coordinate finish painting with Division 09.

3.9 WORKMANSHIP

- .1 Workmanship shall be in accordance with well established practice and standards accepted and recognized by the Consultant and the Trade.
- .2 The Consultant shall have the right to reject any item of work that does not conform to the Contract Documents and accepted standards of performance, quietness of operation, finish and appearance.
- .3 Employ only tradesmen holding valid Provincial Trade Qualification Certificates. Tradesmen shall perform only work that their certificate permits. Certificates shall be available for inspection by the Consultant.

3.10 PROTECTION OF WORK

- .1 Protect equipment and materials, stored or in place, from the weather, moisture, dust and physical damage.
- .2 Mask machined surfaces. Secure covers over equipment openings and open ends of equipment and conduit, as the installation work progresses.
- .3 Equipment having operating parts, bearings or machined surfaces, showing signs of rusting, pitting or physical damage will be rejected.
- .4 Refinish damaged or marred factory finish.

3.11 PROTECTION OF ELECTRICAL EQUIPMENT

- .1 Protect exposed live equipment during construction for personnel safety.
- .2 Shield and mark live parts, e.g. "LIVE 120 VOLTS".
- .3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.

3.12 CONCEALMENT

- .1 Conceal wiring and conduit in partitions, walls, crawlspaces and ceiling spaces, unless otherwise noted.
- .2 Do not install wiring and conduit on outside walls or on roofs unless specifically directed.

3.13 SERVICE PENETRATIONS IN RATED FIRE SEPARATIONS

- .1 All cabling, wiring, conduits, cable trays, etc. passing through rated fire separations shall be smoke and fire stopped to a ULC or cUL tested assembly system, in accordance with CAN4-S115-95, that meets the requirements of the Building code in effect.
- .2 The scope includes new services which pass through existing rated separations and also all existing services which pass through a new rated separation or existing separations whose rating has been upgraded.
- .3 Fire resistance rating of installed firestopping assembly shall not be less than fire resistance rating of surrounding assembly indicated on Architectural drawings. Where this is not indicated assume a minimum of one hour for walls and two hours for floors.
- .4 Install firestopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions. The Applicator shall be approved, licensed and supervised by the manufacturer in the installation of firestopping and are to follow the requirements of a rated system as detailed above.
- .5 Contractors are expected to submit system information detailing firestopping product, backing, penetrant, penetrated assembly, Fire (F) and Temperature (T) rating, and ULC or cUL system number.
- .6 Provide fire stopping material and system information in the maintenance manuals and via labels at major penetrations that are likely to be re-penetrated.
- .7 All penetrations are to be firestopped using EZ Path System (Specified Technologies Inc - STI) only.
- .8 Allow openings for 100% capacity of raceway or 200% capacity of J-hooks.
- .9 Provide split systems where existing cables are involved.
- .10 Provide Firestopping approval certificate in including a Building Code / By-Law Schedule B-1, B-2 & C-B signed by a Yukon registered Professional Consultant. Submit a letter certifying that all work is complete and in accordance with this specification. Electrical Form EF130 in Section 16991 [26 06 02] should be used for this purpose.

3.14 SERVICE PENETRATIONS IN NON-RATED SEPARATIONS

- .1 All cabling, wiring, conduits, cable trays, etc. passing through non-rated fire separations and non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with caulking or silicon sealant to prevent the passage of smoke and/or transmission of sound.

3.15 CONDUIT SLEEVES

- .1 Provide conduit sleeves for all conduit and wiring passing through rated walls and floors. Sleeves to be concentric with conduit or wiring.
- .2 Except as otherwise noted conduit sleeves are not required for holes formed or cored in interior concrete walls or floors.
- .3 Conduit sleeves shall extend 50 mm [2"] above floors in unfinished areas and wet areas and 6 mm [1/4"] above floors in finished areas.
- .4 Conduit sleeves shall extend 25 mm [1"] on each side of walls in unfinished areas and 6 mm [1/4"] in finished areas.
- .5 Conduit sleeves shall extend 25mm [1"] beyond exterior face of building. Caulk with flexible caulking compound.
- .6 Sleeve Size: 12 mm [1/2"] clearance all around, between sleeve and conduit or wiring.
- .7 Paint exterior surfaces of ferrous sleeves with heavy application of rust inhibiting primer.
- .8 Packing of Sleeves:
 - .1 Where sleeves pass through foundation walls and perimeter walls the space between sleeve and conduit shall be caulked with waterproof fire retardant non-hardening mastic.
 - .2 Pack future-use sleeves with mineral wool insulation and then seal with ULC approved fire stop sealant for rated fire separations.

3.16 ACCESSIBILITY AND ACCESS PANELS

- .1 Install all equipment, controls and junction boxes so as to be readily accessible for future modification, adjustment, operation and maintenance as appropriate.
- .2 Provide access panels where required in building surfaces. Do not locate access panels in panelled or special finish walls, without prior approval of the Consultant.
- .3 Access panels in U.L.C. fire separations and fire walls shall have a compatible fire rating and U.L.C. label. Acquire approval in writing from the local fire authority if required.
- .4 Access panels shall be painted with a primer coat if applicable and then with a finish coat, colour and type to the Consultant's approval.
- .5 Locate equipment and junction boxes in service areas wherever possible.

3.17 EQUIPMENT INSTALLATION

- .1 Provide means of access for servicing equipment.
- .2 CSA identification and equipment labels to be clearly visible after installation.

3.18 CUTTING, PATCHING, DIGGING, CANNING, CORING & CONCRETE

- .1 Lay out all cutting, patching, digging, canning and coring required to accommodate the electrical services. Coordinate with other Divisions
- .2 Div. 26 shall be responsible for all cutting, patching, digging, canning and coring required to accommodate the electrical services.

- .3 Be responsible for correct location and sizing of all openings required under Electrical Divisions, including piped sleeves.
- .4 Verify the location of existing and planned service runs and structural components within concrete floor and walls prior to core drilling and/or cutting. Repairs to existing services and structural components damaged as a result of core drilling and cutting is included in this section of the work.
- .5 Openings through structural members of the building shall not be made without the approval of the Structural Consultant.
- .6 Openings in Concrete:
 - .1 Be responsible for the layout of all openings in concrete, where openings are not left ready under previous contract.
 - .2 All openings shall be core drilled or diamond saw cut.
 - .3 Refer to structural drawings for permissible locations of openings and permissible opening sizes in concrete floors and walls.
 - .4 Refer to structural drawings for locations of steel reinforcing.
 - .5 Be responsible for repairing any damage to steel reinforcing.
- .7 Openings in building surfaces other than concrete:
 - .1 Lay out all openings required.
- .8 Poured concrete for duct encasements, pole bases, transformer pads and housekeeping pads shall be provided by other Divisions, coordinated and supervised by the Electrical Divisions.
- .9 Precast concrete items such as transformer pad bases, pull boxes and light pole bases to be provided and installed by the Electrical Divisions unless otherwise specified.
- .10 Excavation and backfilling will be provided by other Divisions. This Division to superintend the work and provide all layouts and parameters.

3.19 PAINTING

- .1 Clean exposed bare metal surfaces supplied under the Electrical Divisions removing all dirt, dust, grease and millscale. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.
- .2 Paint all hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer, as they are installed.
- .3 Repaint all marred factory finished equipment supplied under the Electrical Divisions, to match the original factory finish.
- .4 Coordinate with Division 09.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Division 01 Operation and Maintenance Manuals.
- .3 Section 26 05 00 Common Work Results
- .4 Section 26 05 15, Commissioning of Electrical Equipment Systems
- .5 Sketches ESK-01 and ESK-02 following this Section.

1.2 SCOPE

- .1 Electrical operations and maintenance manuals (hereinafter referred to as O&M manuals) shall be prepared by a firm specializing in this type of work.
- .2 Specialty firm to be responsible for:
 - .1 The supply and preparation of four sets of O&M manual binders and tabs as specified in the index below and detailed in Sketches ESK-01 and ESK-02.
 - .2 The preparation of all written system descriptions and schematics (neatly drafted) for each tab section identified as article 1.4. Format as directed by the Owner, utilizing proportional typewritten format, with schematics in appendices at the end of each section. System description shall include an overview of basic design philosophy, description of future expansion capability, general construction of components, electrical characteristics not readily deduced from the contract documents, basic system configuration and interfaces with other systems existing or new.
 - .3 Securing and assembling all necessary literature describing operational and maintenance procedures for all equipment into the O&M manual binders, including Preventative Maintenance data as described below. Preventative maintenance data and maintenance suggestions to be compiled in tabular format in applicable section to provide a comprehensive overview of maintenance procedures.
 - .4 Preparing in coordination with Electrical Divisions and equipment manufacturer's technical specialist, scheduled maintenance sheets and check lists. Scheduled maintenance sheets shall include safety in maintenance data plus detailed daily, monthly and yearly scheduled maintenance information. Format as directed by the Owner.
 - .5 Preparation of safety in maintenance suggestions and procedures.
 - .6 Summarized daily, monthly and yearly maintenance charts.
 - .7 Prestonia No. 2047-10 plastic sheet protectors for all drawings larger than 210 mm × 275 mm. Locate drawing title block on lower right hand corner.
- .3 Division 26 shall be responsible for:
 - .1 Supplying two [2] printed copies and PDF electronic copy of all information as described below:
 - .1 Final shop drawings.
 - .2 All wiring diagrams.

- .3 List of all major trades, sub-trades and suppliers including names of equipment supplied and by whom, addresses, phone numbers, facsimile numbers and contact persons.
- .4 Obtaining all data necessary to compile a complete comprehensive Preventative Maintenance program. Data gathered shall be neatly handwritten on forms provided by the Owner. Data to be collected for all systems described in the index below.
- .5 Spare/replacement parts lists for all of the above. Copies of the electrical contractor's data collection sheets available during tendering period when requested.
- .6 Test results as outlined in other sections of this specification.

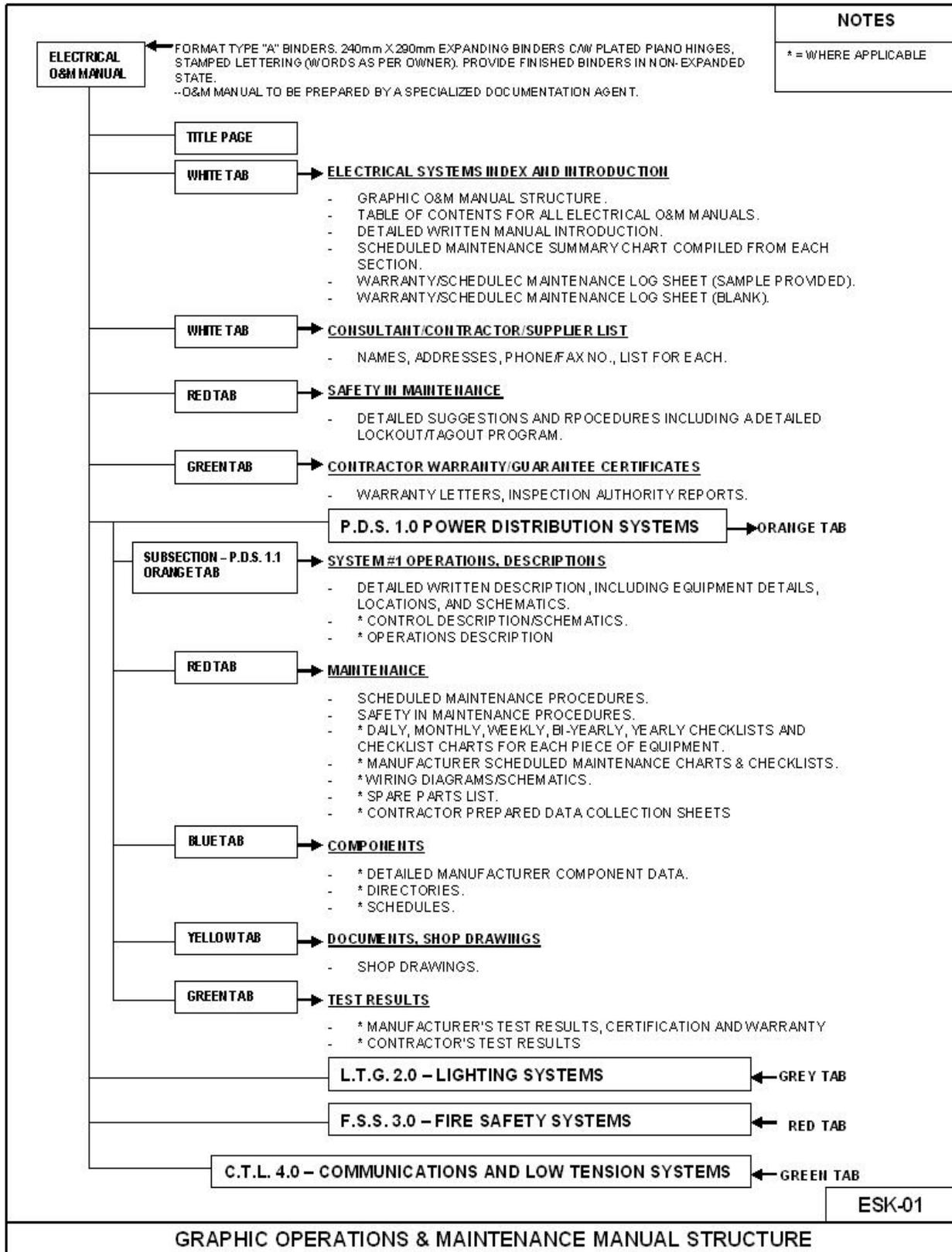
1.3 ELECTRONIC FORMAT

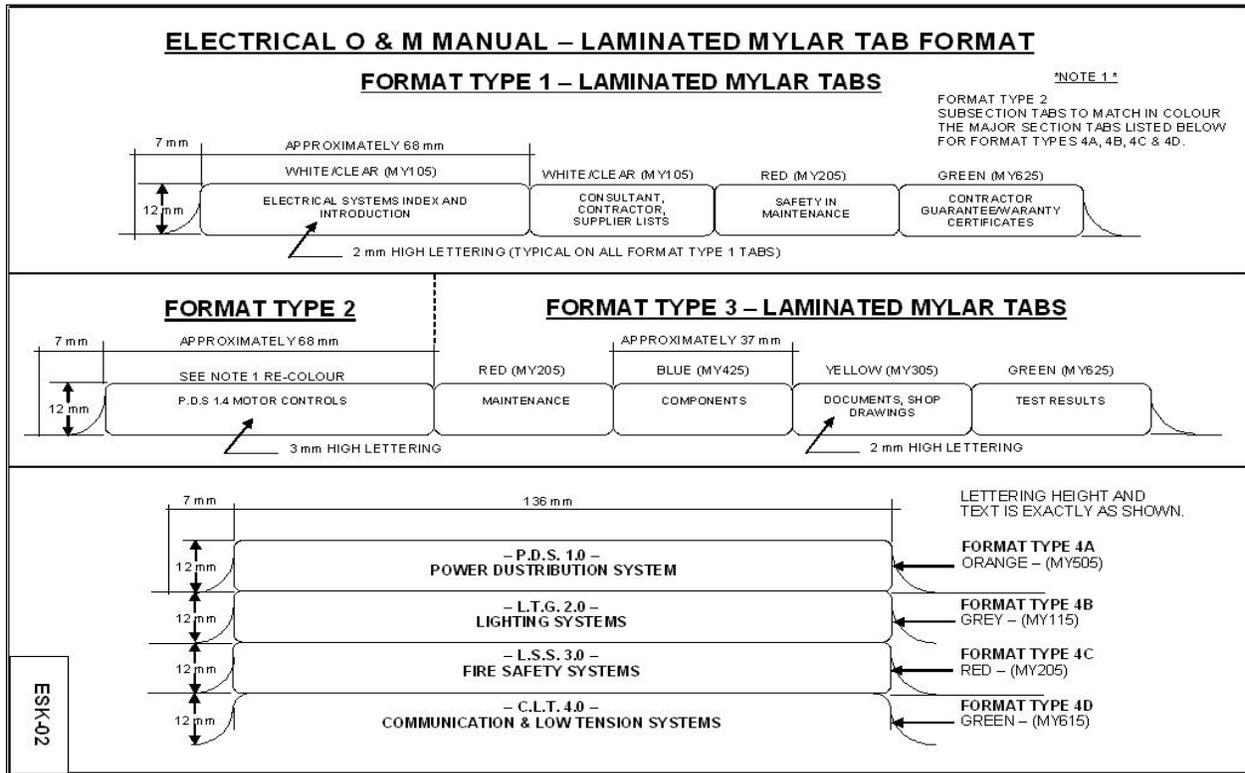
- .1 In addition to the specified hardcopy, provide an electronic copy in pdf format. Electronic copy to be saved on a USB 3.0 (Type A) flash drive.
- .2 USB 3.0 (Type A) flash drive to be reproducible by owner as required to carry out his duties.
- .3 Electronic copy to be divided into chapters to allow a quick and easy access to the different sections of the manual.
- .4 All log sheet, maintenance tables, preventative maintenance sheets intended to be completed by the Owner are to be completely interactive allowing the Owner to complete all pertinent information and save, print or modify these forms as required.
- .5 Provide a proposed layout for approval prior to the construction.
- .6 Electrical contractor to submit complete system description and schematics by 50% complete stage of construction. O&M manuals to be submitted to the Owner 90% complete three (3) months prior to substantial completion inspection.
- .7 Electrical O&M manuals to be assembled in 210 mm × 275 mm capacity, expanding spine catalogue binders complete with plated piano hinges, bound in heavy (*blue*) fabric, hot stamped white lettering on front and spine. Electrical contractor to provide sufficient quantity to allow all binders to hold system data while in full closed position (not expanded).
- .8 Electrical contractor to provide sample of artwork and fabric cover (before having binders constructed) to the Owner.

.9	Tab Name/Description	Tab No.
.1	Incoming Electrical Services	1.0
.1	– Power	
.2	– Telephone	
.3	– RFTV	
.2	Secondary Power Distribution System	1.1
.1	– Main Distribution Switchgear	
.2	– Metering	
.3	– Energy Test Meter	
.4	– Coordination Study	
.5	– TVSS Units	
.3	Transformers	1.3
.1	– Dry Type Transformers	
.2	– Tap Adjustment Data	
.3	– Connection Details	
.4	CDPs/Panelboards	1.4
.1	– 347/600 Volt Distribution Centres	
.2	– 120/208 Volt Distribution Centres	
.3	– Moulded Case Feeder Breakers	
.4	– 347/600 Volt and 120/208 Volt Panelboards	
.5	– 277/480 Volt Distribution Centres and Panelboards	
.6	– Contactors	
.7	– Ground Fault Breakers	
.8	– Final Typewritten Panel Directories	
.9	– Auto Bypass Transfer Switches	
.10	– TVSS Units	
.5	Motor Controls	1.5
.1	– Manual Motor Protection Switches	
.2	– Disconnect Switches	
.3	– Motor Control Centres	
.4	– Single Speed FVNR Starters	
.5	– Overcurrent Protection	
.6	– Single Phase Protection	
.7	– Adjustable Overloads	
.8	– Fire Alarm System Interface	
.9	– Final MCC Schedules	

.6	Power Receptacle Systems	1.6
.1	– Standard Receptacles	
.2	– Emergency Receptacles	
.3	– Ground Fault Interrupter Receptacles	
.4	– USB Combination Receptacles	
.5	– Surface Raceway System	
.7	Grounding System	1.7
.1	– Building Ground Grid	
.2	– Auxiliary Bonding	
.3	– Waste Water Line	
.4	– Gas Piping	
.5	– Low Tension Equipment Grounding	
.8	Power Generation	1.8
.9	Uninterruptable Power Supply	1.9
.10	Miscellaneous Equipment	1.10
.1	– Cable Trays/Wireways	
.11	Interior Lighting Control	2.1
.1	– Line Voltage Switches	
.2	– Dimmer Switches	
.3	– Low Voltage Controls	
.12	Emergency Lighting	2.2
.1	– LED	
.2	– Exit Luminaires	
.3	– Emergency Battery Packs	
.13	Interior Lighting	2.3
.1	– LED	
.14	Exterior Lighting	2.4
.1	– LED	
.2	– Controls	
.15	Fire Alarm System	3.1
.1	– Main Control Panel	
.2	– Annunciators	
.3	– Ancillary Devices	
.4	– Battery Backup	
.5	– Devices	
.6	– Sequence of Operation	

.7	– Interface with Other Systems	
.8	– Block Diagrams	
.9	– Riser Diagram	
.16	RF Television System	4.5
.1	– Cabling	
.2	– Amplifiers	
.3	– Devices	
.4	– Block Diagrams	
.17	Voice / Data Cabling Systems	4.6
.1	– All Component Data	
.2	– Block Diagrams	
.3	– Schematic Diagrams	
.4	– Operation	
.5	– Maintenance	
.6	– Riser Diagram	





End of Section

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification is to be read, coordinated and implemented in conjunction with all other parts of the Contract Documents.

1.2 REGULATORY REQUIREMENTS

- .1 Restraints shall meet the requirements of the latest edition of the British Columbia Building Code and amendments.
- .2 The Seismic Consulting Engineer should be able to provide a proof of professional insurance and the related practice credentials if requested by the Electrical Consultant. The Seismic Consulting Engineer should be familiar with SMACNA, ECABC & NFPA guidelines as well as BCBC requirements.
- .3 The Contractors Seismic Consultant shall submit original signed BC Building Code "Letters of Assurance" to the Prime Consultant or Electrical Consultant.
- .4 The above requirements shall not restrict or supplant the requirements of any local bylaws, codes, or other certified agencies which may have jurisdiction over all or part of the installation.

1.3 SCOPE

- .1 It is the responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.
- .2 Manufacturer's shop drawings to be submitted with seismic information on equipment structure, bracing and internal components and as required by Division 01.
- .3 Provide restraint on all equipment and machinery, which is part of the building electrical services and systems, to prevent injury or hazard to persons and equipment in and around the structure. Restrain all such equipment in its normal position in the event of an earthquake.
- .4 The total electrical seismic restraint design and field review and inspection will be by a Yukon. registered professional structural engineer who specializes in the restraint of building elements. Contractor to allow for coordination, provision of seismic restraints, as well as all costs for the services of the Seismic Restraint Engineer. This engineer, herein referred to as the Seismic Consultant, will provide normal engineering functions as they pertain to seismic restraint of electrical installations.
- .5 The Contractor shall be aware of, and comply with, all current seismic restraining requirements and make provision for those that may come into effect during construction of the project. Make proper allowance for such conditions in the tender.
- .6 The Seismic Consultant shall provide detailed seismic restraint installation shop drawings to the Contractor. Copies of the shop drawings to be included in the final project manual.
- .7 Provide seismic restraints on all equipment, and/or installations or assemblies, which are suspended, pendant, shelf mounted, freestanding and/or bolted to the building structure or support slabs.
- .8 The Seismic Consultant shall provide inspections during and after installation. The Contractor shall correct any deficiencies noted without additional cost to the contract.
- .9 Include all costs associated with the Seismic installation and certification in the base tender.

1.4 SHOP DRAWINGS & SUBMITTALS

- .1 Submit shop drawings of all seismic restraint systems including details of attachment to the structure, either tested in an independent testing laboratory or approved by the seismic consultant.

- .2 Submit all the proposed types and locations of inserts or connection points to the building structure or support slabs. Follow the directions and recommendations of the Seismic Consultant.

Part 2 Products

2.1 SLACK CABLE SYSTEMS

- .1 Slack cable restraint systems shall be as designed and supplied by Vibra-Sonic Control or equal.
- .2 Slack cable restraints shall be provided on suspended and shelf mounted transformers along with associated equipment and assemblies connected to them at the points of vertical support (4 points). The restraint wires shall be oriented at approximately 90° to each other (in plan), and tied back to the ceiling slab or its structure at approximately 45° to the slab or basic structure. The restraints shall be selected for a 1 g earthquake loading, i.e. each wire shall have a working load capacity equal to the weight of the transformer. The anchors in the structure shall be selected for a load equal to the weight of the transformers at a 45° pull.
- .3 Slack cable systems to allow normal maintenance of equipment and shall not create additional hazard by their location or configurations. Contractor shall rectify any such installations at no additional cost, all to the satisfaction of the engineer and inspection authority having jurisdiction.
- .4 Coordinate requirements of slack cables with suppliers prior to installation.

Part 3 Execution

3.1 GENERAL

- .1 All seismic restraints systems shall conform to local authority having jurisdiction and all applicable code requirements.

3.2 CONDUITS

- .1 Provide restraint installation information and details on conduit and equipment as indicated below:
- .2 Vertical Conduit:
 - .1 Attachment - Secure vertical conduit at sufficiently close intervals to keep the conduit in alignment and carry the weight of the conduits and wiring. Stacks shall be supported at their bases and, if over 2 stories in height, at each floor by approved metal floor clamps.
 - .2 At vertical conduit risers, wherever possible, support the weight of the riser, at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 9.2 m [30 ft] o.c.
- .3 Riser joints shall be braced or stabilized between floors.
- .4 Horizontal Conduits:
 - .1 Supports - Horizontal conduit shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.
 - .2 EMT tubing - tubing shall be supported at approximately 1.2 m [4 ft] intervals for tubing.
- .5 Provide transverse bracing at 12.2 m [40 ft] o.c. maximum unless otherwise noted. Provide bracing at all 90° bend assemblies, and pull box locations.
- .6 Provide longitudinal bracing at 24.4 m [80 ft] o.c. maximum unless otherwise noted.
- .7 Do not brace conduit runs against each other. Use separate support and restraint system.

- .8 Support all conduits in accordance with the capability of the pipe to resist seismic load requirements indicated.
- .9 Trapeze hangers may be used. Provide flexible conduit connections where conduits pass through building seismic or expansion joints, or where rigidly supported conduits connect to equipment with vibration or seismic isolators.
- .10 A conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
- .11 Provide large enough conduit sleeves through walls or floors to allow for anticipated differential movements with firestopping where required.
- .12 It is the responsibility of the contractor to ascertain that an appropriate size restraint device be selected for each individual piece of equipment. Submit details on shop drawings. Review with seismic consultant and submit shop drawings to consultants for their reference.

3.3 FLOOR MOUNTED EQUIPMENT

- .1 Bolt all equipment, e.g. transformers, switchgear, generators, motor control centres, free standing panelboards, control panels, capacitor banks, etc. to the structure. Design anchors and bolts for seismic force applied horizontally through the center of gravity to a seismic force of 0.5g. For equipment which may be subject to resonances, use a nominal 1.0 g seismic force.
- .2 Provide flexible conduit connections between floor mounted equipment to be restrained and its adjacent associated electrical equipment.

3.4 LIGHT FIXTURES

- .1 Fixtures in suspended ceilings shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by at least two taught cables which are connected to the fixture at diagonal points.
- .2 Surface and recessed style fixtures shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by taut cables.
- .3 Fixtures which are hung independently of ceiling systems shall have minimum of one seismic cable in addition to the chain or cable used to support the fixture. Seismic restraint cables shall be secured into the concrete or structural deck above.
- .4 Cables shall be corrosion resistant and approved for the application.
- .5 Fixtures which are rod hung shall have seismic ball alignment fittings at the ceiling and fixture.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 22 - Connectors and Terminations
- .2 Section 26 05 34 – Conduits and Conduit Fastenings

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA-C22.2 No. 131-M89(R1994), Type TECK90 Cable.
 - .2 CAN/CSA-C68.10-14 - Shielded Power Cable for Commercial and Industrial Applications, 5-46 kV
- .2 National Electrical Manufacturers' Association (NEMA)/Insulated Cable Engineers Association (ICEA)
 - .1 NEMA WC3-1992/ICEA S-19-81, Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - .2 NEMA WC7-1992/ICEA S-66-524, Cross-Linked Polyethylene Wire and Cable for Transmission and Distribution.

Part 2 Products

2.1 COPPER TAPE SHIELDED POWER CABLE 28000 V

- .1 Manufactured to CSA C68.10
- .2 Conductor: Single copper conductor, Class B compact concentric stranded, size as indicated.
- .3 Conductor Shield: Semi-conducting thermosetting polymeric stress control layer which is free stripping from the conductor and bonded to the insulation.
- .4 Insulation: 133% TR-XLPE rated for 90°C, for 28,000V.
- .5 Insulation Shield: Extruded thermosetting semiconducting shield with controlled adhesion to the insulation providing appropriate balance between electrical integrity and ease of stripping.
- .6 Metallic Shield: Helically applied non-magnetic uncoated copper tape over the insulation shield with a minimum 20% overlap.
- .7 Jacket: Black, sunlight resistant, non-conducting, polyvinyl chloride (PVC) jacket, rated minus 35°C.
- .8 Acceptable manufacturers: General Cable, Phillips, Pirelli, Prysmian, or equivalent

Part 3 Execution

3.1 INSTALLATION

- .1 Install cables on unistrut or cable tray in accordance with Section 33 65 73 – Concrete Encased Duct Banks and Manholes.
- .2 Install cables in ducts and manholes in accordance with Section 26 05 43.01 – Installation of Cables in Trenches and in Ducts.

- .3 Install cables per manufacturer's instructions.
 - .1 Splices are not permitted unless specifically noted in Tender Documents.
 - .2 Bend radius for to the greater or the manufacturer's recommendations or as allowed by the Canadian Electrical Code, typically 12 x cable OD.
- .4 Apply Arc Proofing Tape and secure with Glass Cloth Electrical Tape to all cables that are not protected by conduit, cable tray, direct burial, or termination materials.
 - .1 Use manufacturer's recommendations, and in addition;
 - .2 Clean cable sheath and smooth surface contours with electrical insulation putty
 - .3 Apply half lapped arc proofing tape over full length of exposed cable
 - .4 Secure arc flash tape with a 150mm banding of half lapped glass cloth electrical tape at each end to hold the arc flash tape in place.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results for Electrical
- .2 Section 26 05 05 - Seismic Restraint
- .3 Sections 01 91 13, 01 91 14, 01 91 15

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No.0.4-04 Bonding of Electrical Equipment, Incl. all updates.

1.4 GENERAL

- .1 Commissioning of the electrical systems shall be in accordance with the Code of Practice and industry standards for Commissioning Electrical Systems in Industrial Facilities and as described in this section.
- .2 Work specified in this section shall be the responsibility of Division 26.

1.5 QUALIFICATIONS OF COMMISSIONING REPRESENTATIVE

- .1 The Electrical Commissioning Representative shall meet the following qualifications:
 - .1 Minimum of 10 years of recent experience in Commissioning of electrical systems for a variety of industrial processes and systems.
 - .2 The Electrical Commissioning Representative shall be a team member of Division 26 and qualified electrical journeyman or Professional Engineer.

Part 2 Products

2.1 THE COMMISSIONING TEAM

- .1 The Commissioning Team shall consist of the Contractor and team member of Divisions 26, 27, and 28.
- .2 The Commissioning work in this section is the responsibility of Division 26.
- .3 Division 26 shall appoint a qualified and experienced foreman as an Electrical Commissioning Representative (ECR).

2.2 DUTIES OF THE ELECTRICAL COMMISSIONING REPRESENTATIVE (ECR)

- .1 The duties of the team are summarized below:
 - .1 The ECR shall plan, organize and implement the electrical commissioning process.
 - .2 The ECR shall prepare the commissioning plan and provide or coordinate demonstration and instructions to the Owner's staff over a period of time to enable the staff to become familiar with the systems.
 - .3 Divisions 26, 27, and 28 to coordinate to meet overall commissioning process required of the Owners Commissioning Authority, including participation in Commissioning meetings, providing updates to the Cx schedule, Cx documentation requirements, and facilitation of CA witnessing of electrical system functional testing activities.

2.3 COMMISSIONING SCHEDULE

- .1 Within 1 week of commencing with the project work the ECR shall review design intent and intended commissioning procedures with the Owner and Division 26. One week later submit a detailed plan identifying the orderly progression of the pre-start commissioning check and subsequent commissioning performance check of each shop equipment, leading up to the ultimate commissioning of all the shop equipment.
- .2 ECR to submit a schedule for the commissioning phase of the work. This schedule shall show:
 - .1 Completion dates for each equipment and installation.
 - .2 Timing of the various phases of the commissioning, testing, balancing and demonstration process.
 - .3 Submission dates for the various documents required prior to verification of commissioning by the Owner's Representative and Commissioning Authority.
 - .4 Prepare a commissioning statement in which each of the four phases that the process is perceived to be worked through. In sequence, the phases are expected to be:
 1. Phase 1 – System Readiness;
 2. Phase 2 – System Start-up, Testing, etc.;
 3. Phase 3 – Verification of System Commissioning;
 4. Phase 4 – Demonstration and Instruction.
- .3 With the commissioning schedule noted above, submit a copy of all commissioning worksheets to be used during the commissioning process.
- .4 Each phase is applicable to each major and separate system making up the work in Divisions 26, 27, and 28.

2.4 COMMISSIONING PHASE

- .1 **Phase 1** – Before starting any of the separate systems, provide written verification stating that the specific system is ready for start-up and the following conditions have been met:
 - .1 Copies of all test and certificates (site testing reports, manufacturer's production test records, and provincial electrical inspector final inspection certificate) have been submitted to the Owner's Representative.
 - .2 All controls and safety interlocks installed and fully operational (dry run test).
 - .3 All cleaning is complete.
 - .4 Pre-start checks are complete.
 - .5 All equipment and tools necessary to perform testing, adjusting and balancing as required.
 - .6 All equipment is installed and connected.
 - .7 Vibration isolation and seismic restraints completed.
 - .8 All cabling and wiring are completed.
 - .9 Control functional checks, including completing all interconnection wiring, alarms, and interlocks are performed.
 - .10 Start-up verification checks by manufacturer's representatives completed.

- .11 All deficiencies to be recorded, reviewed by the commissioning team, and subsequently corrected before proceeding to the next phase, Phase 2.
- .2 **Phase 2** – System Commissioning shall include but not necessarily be limited to:
 - .1 Activation of all systems and installation.
 - .2 Testing and adjustment of all systems.
 - .3 As in the case of the System Readiness Phase, all deficiencies are to be recorded, reviewed by the Commissioning team and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.
 - .4 Phase 2 is concluded when the installation is in full working order and acceptable for use. The work will include the following:
 - 1. Testing of equipment operation.
 - 2. Insulation resistance testing for all power and control wiring.
 - 3. Ground resistance test to CSA C22.2 No.0.4-04.
 - 4. Load balance testing.
 - 5. Power factor testing.
 - 6. Voltage testing and adjustment.
 - .5 Fine Tuning/calibration:
 - 1. Load balancing at panel board.
 - 2. Correct power factor.
 - 3. Re-calibrate circuit breakers tripping.
 - .6 Testing:
 - 1. The ECR shall perform a detailed check of the following:
 - .1 All items and functions to be later demonstrated to the Owner's Representative.
- .3 **Phase 3** – Verification of Commissioning:
 - .1 Verification of commissioning by the Owner's Representative and Commissioning Coordinator shall not commence until the commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:
 - 1. Operation of equipment.
 - .2 At the completion of Phase 3, the ECC shall submit the following to the Owner's Representative:
 - 1. A letter certifying that all work specified under this Contract is complete, clean and operational in accordance with the specification and drawings.
 - 2. A copy of Phase 2 Verification Certificates provided by the specialist trades for submission to the Owner's Representative.
 - 3. Record drawings as specified.
 - 4. A letter from ECR certifying that all necessary data for inclusion in operation and maintenance manuals has been received.

- .3 Upon receipt of all documents and a satisfactory outcome of the verification procedure, the Owner's Representative will provide a Certificate of Verification for Phase 3.
- .4 Substantial Performance may, thereupon, be declared.
- .4 **Phase 4** – Each phase is applicable to each major and separate system making up the entire work in Divisions 26, 27, and 28.
 - .1 Verification of commissioning by the Owner's Representative and Commissioning Authority shall not commence until the commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure.

Part 3 Execution

3.1 GENERAL

- .1 Test all wiring devices for correct operation.
- .2 Test all receptacles and outlets for proper polarity and circuitry.
- .3 Check for circuit labelling.
- .4 Examine firestopping assembly is installed as per it ULC listing. Allow for 1% destructive testing of installed firestopping. All assemblies tested shall be repaired.

3.2 SYSTEMS TO BE COMMISSIONED

- .1 Generator
- .2 600V and 120/208V Distribution Switchboards
- .3 277/480V Distribution Switchboards
- .4 Building Ground system
- .5 Step down transformers
- .6 Branch circuit panelboards
- .7 Fire Alarm System by FA supplier
- .8 Luminaires
- .9 Low Voltage Lighting Controls and dimming controls
- .10 Low Voltage Power Receptacle automatic controls
- .11 Sub-Distribution Centres
- .12 Data cabling system by Data supplier
- .13 Security systems, Access Control Systems, Video Surveillance Systems, and Panic Duress Systems.

3.3 SEISMIC RESTRAINTS

- .1 Ensure conduit & cable tray installation properly secured and equipment are bolted down or fastened to wall in accordance with Section 26 05 05 - Seismic Restraints.

3.4 STRUCTURED CABLING TESTING/COMMISSIONING

- .1 The Contractor shall employ competent cable installers who are trained and certified by TE Connectivity or equivalent.
- .2 Prior to the commencement of functional and electrical performance testing shall be inspected for all systems visually. The installation and interface equipment will be inspected for compliance with the Industry Standards with particular attention given to the following criteria:
 - .1 Neatness, clamping, and harnessing of cabling and wiring,
 - .2 Wire and cable identification and labelling,
 - .3 Cable and connections, ground clamps, and terminal strips,
 - .4 Completeness,
 - .5 Nameplates, identification plates, and markings,
 - .6 Safety,
 - .7 Grounding,
 - .8 Continuity and polarity.
- .3 Testing:
 - .1 All testing shall be performed end to end from the patch panel to data jack after final installation is completed. Testing is to meet or exceed the performance requirement of EIA/TIA 568A, TSB67, and SP195.
 - .2 Permanent Link tests will be performed as per Industry specifications.
 - .3 All horizontal data cables shall be tested individually, and test results will include Closet No., Room / Office No., and Data Label No.
 - .4 Horizontal cables will only be accepted if they 'PASS' the Industry Standard Permanent Link Test parameters defined for the category of cable being tested.
 - .5 The Contractor shall supply the Owner and the Consultant with test results for approval and system acceptance, presented in electronic disk format (CSV format). All test results are to be supplied in an electronically searchable format, via email to the Facilities Management Project Officer and Camosun Network Services as soon as the testing is complete.
 - .6 Test results must include the Telecommunication Room number from which cables terminate and indicate the following information:
 1. Telecommunication Room
 2. Room number of outlet box location
 3. Communication jack number
 - .7 Example: A cable runs from Telecommunication Room 140 to office 115, Data Jack D04, therefore it would have a test label ID of '115RM140D04'.

3.5 FIRE ALARM TESTING/COMMISSIONING

- .1 As per section 28 31 00 - Addressable Fire Alarm System.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Refer to Division 27 & 28 for particular Communications, Electronic Safety & Security wiring systems and types.

1.2 TERMS OF REFERENCE

- .1 Typically use insulated 98% conductivity copper conductor wiring enclosed in EMT (steel) conduit for the general wiring systems unless otherwise indicated. Refer to "Site Services" Section for allowable site conduits as an alternative to steel.
- .2 Teck cable may only be used where specifically indicated on the drawings or in the specifications. Where permitted, Teck wiring up to 750 system volts to be PVC jacketed armoured cable, multi-copper conductor type Teck90 1000 volt having a PVC jacket with FT-4 flame spread rating.
- .3 Flexible armoured cabling (BX) shall not be used for the general wiring system other than final drops to recessed light fixtures in concealed locations.
- .4 Cabling indicated to be 2-Hour Fire-Rated shall be Mineral Insulated or compliant to CAN/ULC-S139 and CSA 38-95. Cabling shall be low smoke halogen free. Conduit to be sized and installed as per manufacturers requirements for these specialized cables and assemblies regardless of the size indicated on drawings.
- .5 Provide all control wiring except HVAC controls as specified in Mechanical Divisions.
- .6 Refer to Equipment Schedule(s) for detailed responsibilities.
- .7 Non-metallic sheathed wiring is not to be used on this project.

1.3 PRODUCT DATA

- .1 Provide product data in accordance with Division 01

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 - Construction/Demolition Waste Management And Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

Part 2 Products

2.1 WIRING & CABLES – GENERAL

- .1 Conductors: stranded for 10 AWG and larger. Minimum size #12 AWG.
- .2 Insulation to be 600 volt RW90 XLPE (X link) for the general building wiring in conduit.
- .3 Use RWU90 XLPE for underground installations.
- .4 Site services sub-circuits, including site lighting, to be minimum #10 AWG for power and #12 for controls. Increase wiring size so that system will not exceed the maximum voltage drop as required by the Canadian Electrical Code CSA 22.1.
- .5 Main feeders to be conduit and copper insulated wiring unless otherwise noted on drawings. Provide ground wiring for all conduits in or below slabs. Increase conduit size as required.

- .6 Armoured (BX) cable may only be utilized for recessed tee bar luminaire drops from ceiling mounted outlet boxes. "Tite Bite" connectors and their counterparts of other manufacturers shall not be used. Use anti-short connectors. Cable from luminaire to luminaire is discouraged. Allow nominally 900mm [3'] extra cable looped and supported in the ceiling space to permit fixture relocations of one tile space.
- .7 TBS90 #14 AWG stranded shall be used in all switchgear assemblies. Current transformer secondary wiring shall be #12 AWG stranded. Current transformer leads shall incorporate ring type tongues for termination purposes
- .8 Conductors to be colour-coded. Conductors No.10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No.8 gauge and larger may be colour-coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible. Where colour-coding tape is utilized, it shall be applied for a minimum of 50 mm at terminations, junctions and pullboxes and conduit fittings. Conductors not to be painted.

2.2 **TECK 90 CABLE**

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors: copper and sized as indicated.
- .3 Insulation: Chemically cross-linked thermosetting polyethylene rated type RW90XLPE,600V
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: flat galvanized steel.
- .6 Overall covering: PVC jacket with FT-4 flame spread rating. PVC flame retardant jacket over armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.
- .7 Fastenings:
 - .1 One (1) hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two (2) or more cables.
 - .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Connectors: Watertight approved for TECK cable

2.3 **MINERAL INSULATED (MI) OR TWO HOUR FIRE RATED CABLE ASSEMBLIES**

- .1 MI Conductors: solid bare soft-annealed copper, size as indicated.
- .2 MI Insulation: compressed powdered magnesium oxide to form compact homogeneous mass throughout entire length of cable.
- .3 Overall MI covering: annealed seamless copper sheath rated 600 V.
- .4 For MI exposed and surface locations provide an FT-4 PVC outer jacket: applied over sheath.
- .5 Two hour fire rating.
- .6 Cable end terminations to be done under the direction of the manufacturers supervision or alternatively measured and factory prepared.
- .7 Alternately, where indicated 2-Hour Fire-Rated conduit and wire assemblies may be used and shall be compliant to CAN/ULC-S139 and CSA 38-95. Cabling shall be low smoke halogen free. Conduit to be sized and installed as per manufacturers requirements for these specialized cables and assemblies regardless of the size indicated on drawings.

2.4 **ARMoured CABLE (BX)**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90 600 V rated.
- .3 Armour: interlocking type fabricated from galvanized steel.
- .4 Anti-short connectors.

2.5 **LOW VOLTAGE CONTROL CABLES**

- .1 Type LVT: soft annealed copper conductors, with thermoplastic insulation, outer covering of thermoplastic jacket. Minimum size #18 AWG.
- .2 Unless otherwise specified wiring to be multicore individually identified and colour coded with grey sheath enclosed in conduit or (EMT).

2.6 **WIRE & BOX CONNECTORS**

- .1 Pressure type wire connector current carrying parts to be copper and sized to fit conductors used.
- .2 Fixture type splicing connector current carrying parts to be copper sized to fit conductors 10 AWG or less.
- .3 Bushing stud connectors to EEMAC 1Y-2 and suitable for stranded copper conductors
- .4 Clamps or connectors for armoured cable, flexible conduit, as required.

Part 3 **Execution**

3.1 **INSTALLATION**

- .1 Install all cables and wiring.
- .2 Conductor length for parallel feeders to be identical. Provide permanent plastic nametag indicating load fed.
- .3 Group Teck, Armoured, MI & Sheathed cables on channels wherever possible.
- .4 Lace or clip groups of feeder conductors at all distribution centres, pullboxes, and termination points.
- .5 Wiring in walls should typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls should be avoided unless indicated.
- .6 All grounding conductors and straps to be copper. All bonding conductors to have green insulation jacket.
- .7 Colour coding to be strictly in accordance with Section 26 05 00.
- .8 Provide sleeves where cables enter or exit cast concrete or masonry.
- .9 Power wiring up to and including No.6 gauge shall be spliced with nylon-insulated expandable spring-type connectors. Large conductors shall be spliced using split-bolt or other compression type connectors wrapped with cambric tape then PVC tape.
- .10 Wires shall be sized for 2% maximum voltage drop to farthest outlet on a loaded circuit. Increase home run cable size to meet these requirements.
- .11 All branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .12 Install all control cables in conduit.

- .13 Provide numbered wire collars for all control wiring. Numbers to correspond to control drawing legend. Obtain wiring diagram for control wiring of other Divisions.

3.2 VOLTAGE REGULATION

- .1 The drawings are diagrammatic and indicate the general routing of conduit runs and not exact routing, either horizontally or vertically.
- .2 Branch circuit conductor sizes shall be #12 AWG or larger based on the Canadian Electrical Code CSA 22.1 Section 8, which allows a maximum 3% voltage drop for branch circuits. Refer also to ASHRAE 90.1-2010 for voltage regulation.

3.3 WIRE & BOX CONNECTORS

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65
 - .2 Install fixture type connectors and tighten. Replace insulating cap.
 - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)
- .2 Transformer grounding shall comply with CSA C22.2 No.41.
- .3 All grounding conductors to be stranded soft annealed copper unless otherwise noted.
- .4 Install complete grounding and bonding system in accordance with Canadian Electrical Code and local inspection authority requirements.

1.4 TESTING REQUIREMENTS

- .1 Provide “Fall of Potential” tests and the corresponding “Touch & Step” calculations for high voltage installations.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions. Measure ground grid resistance.
- .3 Any third party testing agency costs for the testing and reporting shall be included in the Electrical Division base tender and shall be carried out by a pre-approved testing agency.

1.5 ADDITIONAL SCOPE

- .1 Refer to drawings for extent of grounding in addition to code requirements.

Part 2 Products

2.1 MATERIALS

- .1 Grounding equipment to: CSA C22.2 No.41.

2.2 EQUIPMENT

- .1 Clamps for grounding of conductor, size as required.
- .2 Copper conductor at least 6m [20'] long for each concrete encased electrode, bare, stranded, soft annealed, size as indicated. If not indicated, use 3/0AWG which is the maximum in Table 43 CEC.
- .3 Rod electrodes, copper clad steel 20mm [3/4"] dia by 3m [10'] long or as indicated.
- .4 System and circuit, equipment, grounding conductors, bare stranded copper, soft annealed, sized as indicated. Insulation where specified or required to be green.
- .5 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.
- .6 Non-corroding accessories necessary for grounding system, type, size material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.

- .2 Protective type clamps.
- .3 Bolted type conductor connectors.
- .4 Thermit welded type conductor connectors.
- .5 Bonding jumpers, straps.
- .6 Compression type connectors.

2.3 STANDARDS OF ACCEPTANCE

- .1 Acceptable manufacturers:
 - .1 Burndy Corp.
 - .2 Erico Inc
 - .3 Cadweld.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.
- .2 Provide ground wire in EMT conduits installed in grade or below slabs.
- .3 Install connectors in accordance with manufacturer's instructions.
- .4 Protect exposed grounding conductors from mechanical injury.
- .5 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process or permanent mechanical connectors approved for the use.
- .6 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .7 Soldered joints not permitted.
- .8 Install bonding wire for flexible conduit, connected at both end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit. Provide a ground conductor in all flexible conduit and secure to system grounding lugs at both the equipment and source.
- .9 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .10 Install separate ground conductor to each outdoor lighting standard.
- .11 Connect building structural steel and metal siding to ground by welding copper to steel.
- .12 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .13 Bond single conductor, metallic armoured cables to cabinet at supply end and provide non-metallic entry plate at load end.
- .14 Ground secondary service pedestals.
- .15 Coordinate ground rod installation with local soil conditions to assure proper grounding system.
- .16 Provide a grounding/bonding bus in each electrical room and in the Generator room. Connect a #2/0cu bonding conductor or as shown on the drawings between grounding/bonding buses.

- .17 Provide a bonding conductor appropriately sized within each raceway routed within the building.
- .18 All bonding and grounding connections to be compression type unless noted otherwise.
- .19 Bond bonding bus of switchboard to the grounding grid with a #3/0 copper conductor.
- .20 Ground the secondary winding of potential and current transformers.
- .21 Supply and install complete grounding and bonding system as indicated and as required by Canadian Electrical Code and the local electrical inspection authorities.
- .22 Provide grounding/bonding bus bars mounted on standoff insulators or as shown on the drawings.
- .23 All components shall be securely and adequately bonded and where required to accomplish this, bonding jumpers, grounding studs and bushings shall be used.
- .24 Ensure that all raceways, terminal panels, etc. for fire alarm, etc. are securely and adequately bonded and provide grounding conductor to main ground bus where called for or when required.
- .25 All interior metallic gas piping which may become energized to be made electrically continuous and to be bonded in accordance with requirements of Canadian Electrical Code.
- .26 Bond all low tension equipment with #6 AWG bonding conductor.
- .27 Bond all structural steel, all concrete reinforcing steel and all metal systems with a #2 copper bonding conductor. Connect to closest ground bus or bonding point.

3.2 ELECTRODES

- .1 Provide and install an artificial ground consisting typically of 3000mm [10'] x 20mm [3/4"] copperweld ground rods, interconnected by bare stranded copper #4/0 conductor and terminating to the Main Electrical Room ground bus. Conductors shall be connected to the ground rods and shall be buried below grade. Check and measure the installation to ensure an adequate resistance to ground before floor slab cover pour. Refer to drawings for details.
- .2 Provide additional grounding as necessary to meet the ground resistance specified.
- .3 In certain difficult circumstances, in-situ concrete encased grounding conductors ("UFER") grounding may be used to enhance grounding grid system.
- .4 Provide ground test well over ground rods on the ground grid to allow access to the grid for testing. Refer to drawings for details.

3.3 BUILDING SERVICES BONDING

- .1 WATER - From the main electrical room ground bus, connect 1#3/0 insulated ground conductor in 27mm [1"] conduit to water main with approved ground clamp ahead of water meter. Install 1#3/0 ground conductor jumper strapped around water meter and associated unions and valves to ground building side of water system.
- .2 METALLIC WASTE WATER PIPING - Each metallic waste water piping system to the building to be grounded by bonding it to the interior metallic water supply system by copper bonding jumper of not less than No.6 AWG as per the Canadian Electrical Code
- .3 GAS PIPE GROUNDING - All interior metallic gas piping which may become energized to be made electrically continuous and to be bonded in accordance with requirements of Canadian Electrical Code.

3.4 GROUNDING BUSSES

- .1 Provide a ground bus in the main electrical room. Ground bus shall consist of suitable length of 50mm x 6mm [2"x ¼"] copper bus mounted on a 25mm [1"] insulating standoffs. This bus shall be drilled and tapped to receive all the grounding conductors indicated and an engraved nameplate or tag installed above or below individual conductors indicating their function.
- .2 Provide similar ground bus in each sub electrical room and major mechanical room. Interconnect to the main ground bus with a 3/0 AWG insulated copper grounding conductor that is typically installed with the power feeders.
- .3 Provide similar ground bus in each data and voice equipment room and closet as indicated in "Data & Voice Grounding" clause.
- .4 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 3/0 AWG or as indicated.
- .5 Copper or bronze lugs required for termination of all copper conductors at ground busses.

3.5 EQUIPMENT GROUNDING OR BONDING

- .1 Install grounding or bonding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, UPS, control panels, building steel work, generators, elevators, distribution panels and outdoor lighting.
- .2 Provide a grounding conductor from the secondary of every distribution transformer to the grounding system. Ground conductor to be sized and installed in accordance with Canadian Electrical Code.
- .3 Provide grounding conductor(s) from all major switchgear to solidly ground the secondary system. This includes equipment located in the main electrical room as well as each sub-electrical room. Grounding conductors to be sized to Canadian Electrical Code and switchgear manufacturer's requirements.

3.6 MECHANICAL EQUIPMENT GROUNDING

- .1 Provide a #2 ground conductor from the mechanical room ground bus to each MCC.
- .2 Provide a ground conductor to each VFD sized in accordance with Section 10 of the Canadian Electrical Code (CEC), Part 1.
- .3 Ground wires to be installed in all conduit serving motor feeder circuits and to extend to ground screws on junction and outlet boxes for bonding.

3.7 EMERGENCY GENERATOR GROUNDING

- .1 Ground unit frame, control panel and switchgear in accordance with Canadian Electrical Code (CEC), Part 1.
- .2 Provide a grounding conductor in switchgear to solidly ground emergency system neutral. Grounding conductor to be sized to CEC and switchgear manufacturer's recommendations.
- .3 Generator neutral ground to be connected at generator input side of generator breaker.
- .4 If a four pole automatic transfer switch is utilized provide a grounding conductor from generator switchgear to solidly ground emergency system neutral. Grounding conductor to be sized to Canadian Electrical Code and switchgear manufacturer's requirements.

3.8 SYSTEMS GROUNDING

- .1 Install home run a #6 AWG insulated bonding conductor in conduit from the main ground bus to the:

- .1 Main Fire Alarm panel
- .2 Main Security panel.
- .3 Sound and Communication systems head end.
- .4 RF Television system
- .5 Nurse Call head end
- .6 Uninterruptable Power Supply (UPS) system(s)
- .7 Each Flammable Storage Cabinet (to nearest ground point).

3.9 DATA & VOICE GROUNDING

- .1 Install home run insulated ground conductor in conduit from the building main ground bus as follows:
 - .1 #2 AWG to a ground bus in the main data equipment room.
 - .2 #2 AWG to a ground bus in the main telephone equipment room.
 - .3 #2 AWG to a ground bus in each telephone backboard in equipment rooms/closets.
- .2 Unless otherwise solidly bonded, bond all data and telephone incoming and outgoing steel conduits with insulated 1#12 AWG from the nearest "Communication" ground bus.
- .3 Provide telephone grounding system in accordance with telephone company's requirements.

3.10 CABLE TRAY BONDING

- .1 Install 1#6 to each cable tray from nearest ground bus.
- .2 Install 1#6 bare copper ground, unless shown otherwise, for full length of tray bonded to tray at 15m [50'] intervals and to ground bus at each termination point as specified.

3.11 ACCESS FLOOR BONDING

- .1 Install 1#4 ground connection to every fourth floor pedestal of the access flooring structural support system and make connection to a server room ground bus installed on the wall below the raised floor. From ground bus install one 3/0 ground to ground bus in main electrical room.

3.12 SERVICE BOXES (MANHOLES)

- .1 Install conveniently located fixed and secured corrosion resistant grounding stud in each manhole and terminate the system grounding conductors.
- .2 Install ground rod in each manhole where indicated so that top projects through bottom of manhole. Provide with lug to which grounding connection can be made.

3.13 POST MOUNTED LUMINAIRE BONDING

- .1 Provide #10 AWG bonding conductor with green RW90 X-link insulation to luminaire standards. Connect to luminaire corrosion resistant ground stud or ground clamp.
- .2 Terminate conductors on grounding studs in service boxes.

3.14 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions.

- .3 Measure ground grid resistance with earth test megohmmeter and install additional ground rods and conductors as required until resistance to ground complies with Code requirements and is less than 1Ω .
- .4 Carry out all tests required by the Electrical Inspection Authority and provide all required reports and copied to the Consultant. Include all associated costs.
- .5 Ensure test results are satisfactory before energizing the electrical system.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

- .1 Supply and install all hangers, supports and inserts for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

1.2 RELATED WORK

- .1 Division 01 - Waste Managing and Disposal.
- .2 Section 26 05 05 – Seismic Restraints.

1.3 REFERENCES

- .1 National Research Council of Canada (NRCC)
 - .1 National Building Code of Canada (NBCC)

Part 2 Products

2.1 FRAMING AND SUPPORT SYSTEM

- .1 Materials:
 - .1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.
 - .2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.
- .2 Finishes:
 - .1 Outdoors, wet locations: Hot dipped galvanized.
 - .2 Indoors, dry locations: Galvanized when available, prime painted if not available.
 - .3 Nuts, bolts, machine screws: Cadmium plated.
- .3 Unistrut:
 - .1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50mm and larger.

2.2 CONCRETE AND MASONRY ANCHORS

- .1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.
- .2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.
- .3 Manufacturer: Hilti (Canada) Limited or approved equal.

2.3 NON-METALLIC ANCHORS

- .1 Material: Plastic anchors for sheet metal screws.
- .2 Manufacturer: Fischer.

2.4 CONDUIT SUPPORTS

- .1 General: Malleable iron two-hole conduit straps where exposed to weather. Stamped steel two-hole straps indoors.
- .2 Structural Steel: Crouse-Hinds “Wedgetite” supports or equivalent manufactured by Appleton.

- .3 Masonry, concrete, stone, etc.: Plastic or lead Anchors, suitable for the weight loads.
- .4 Drywall: Toggle bolts.
- .5 Metal studs, ceiling hangers, etc.: "Caddy-Clips".
- .6 Unistrut: Conduit clamps.

2.5 CABLE SUPPORTS AND CLAMPS

- .1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous or approved stainless steel or aluminum clamps shall be used.

Part 3 Execution

3.1 GENERAL

- .1 Do not cut or drill beams, joists or structural steel unless written permission of the Engineer is obtained.
- .2 Distance between conduit or cable supports not to exceed code requirements.
- .3 Supports to be suitable for the real loads imposed by equipment.
- .4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 meter span and 8 mm over a 2 meter span.
- .5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .6 Provide conduit rack with 25% spare capacity for multiple runs.
- .7 Provide channel support with fittings for vertical runs of conduit and cables.

3.2 INSTALLATION

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .4 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole malleable iron or steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .5 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia. threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia. threaded rod hangers where direct fastening to building construction is impractical.
- .6 Shot driven pins may only be used with written approval of the structural engineer.
- .7 Use round or pan head screws for fastening straps, boxes, etc.
- .8 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.

- .9 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .10 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .11 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Owner's Representative.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data for cabinets in accordance with Section 26 05 00

Part 2 Products

2.1 SPLITTERS

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs, connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2 JUNCTION AND PULL BOXES

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm [1"] minimum extension all around, for flush-mounted pull and junction boxes.

2.3 CABINETS

- .1 Type E: sheet steel, hinged door and return flange overlapping sides, handle and catch, for surface mountings.
- .2 Type T: sheet steel cabinet, with full length hinged door, latch, lock, 2 keys, containing 19 mm G1S fir plywood backboard for surface or flush mounting as appropriate.
- .3 Include filtered vents and/or fan-cooling when enclosed equipment is heat producing.

2.4 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00.

Part 3 Execution

3.1 SPLITTER INSTALLATION

- .1 Install splitters as indicated and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible spaces.
- .2 Only main junction and pull boxes are indicated. Provide pull boxes so as not to exceed 30 m of conduit run between pull boxes.
- .3 Provide pull boxes and junction boxes in locations shown on the drawings and as required to suit job conditions.
- .4 Locate pull boxes and junction boxes above removable ceilings, in electrical rooms, utility rooms or storage areas.
- .5 Junction boxes, when used, to be installed in areas that are accessible through luminaire openings, and/or access panels.
- .6 Where pull boxes are flush mounted, provide overlapping covers with flush head cover retaining screws, prime coated and painted to match wall or ceiling finish.

- .7 Where cast corrosion resistant boxes are used, covers to be of matching type and gasketed.
- .8 For special (not 100mm [4"] square or octagonal) pull boxes and/or junction boxes, paint identification for the system and provide lamicoïd nametags to box covers with a size 2 nameplate 5mm [0.25"] lettering identifying system.
- .9 Interior of all pull boxes and junction boxes for each system to be spray painted with colour as specified in Section 26 05 00
- .10 All pull boxes, junction boxes and cabinets to be supported directly from building structure using one or a combination of galvanized screws, galvanized bolts, galvanized rods, and approved box clip.
- .11 Support of pull boxes, junction boxes by conduit fittings or wire is not acceptable.

3.3 CABINETS INSTALLATION

- .1 Mount cabinets with top not higher than 2 m [6'] above finished floor.
- .2 Cabinets shall be flush mounted in finished areas where depth can be accommodated in the walls. Provide flush trim to suit.
- .3 Provide fit up in Type T cabinets as indicated.

3.4 IDENTIFICATION

- .1 Install size 2 identification labels indicating system name, voltage and phase in accordance with Section 26 05 00

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 - Construction/Demolition Waste Management And Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES IN GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm [4"] square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped. Do not use sectional boxes.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347V outlet boxes for 347V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm [3" x 2" x 1.5"] or as indicated. Larger 102 mm square x 54mm deep [4"x 2"] outlet boxes (No. 52151 or 52171) to be used when more than one conduit enters one side. Provide extension and plaster rings as required.
- .2 For larger boxes use GSB solid type as required.
- .3 Boxes for surface mounted switches, receptacles, communications, telephone to be 100mm square No. 52151 or 52171 with Taylor 8300 series covers.
- .4 Lighting fixture outlets: 102 mm [4"] square outlet boxes (No 52151, 52171 or 72171) or octagonal outlet boxes (No 54151 or 54171).
- .5 102 mm [4"] square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster and/or tile walls.

2.3 MASONRY BOXES

- .1 Electro-galvanized steel masonry single and multi gang type MDB boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

- .1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 FLOOR BOXES

- .1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with flanged cover assemblies. The cover assemblies to be die-cast aluminum, provide barriers between the power and low voltage section. A minimum of two (2) gangs for single service applications, and a minimum of two (2) gangs for power and two (2) gangs for communications devices. Device mounting plates to accommodate

short or long ear receptacles. Minimum depth: 73mm.

- .2 Adjustable, concrete tight floor boxes allowing for conduit sizes of 16 mm to 53 mm (with threaded hub).
- .3 Acceptable Manufacturers:
 - .1 Wiremold RFB4 series
 - .2 Hubbell CFB series

2.6 SURFACE CONDUIT BOXES

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

2.7 FITTINGS – GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of foreign materials.
- .3 Conduit outlet bodies for conduit up to 35 mm [1.25"] Use pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

- .1 Typical outlet box mounting heights are indicated in Section 26 05 00 or refer to wiring device and communication specification sections and to architectural layouts for particular mounting heights of outlet boxes where indicated.
- .2 Support boxes independently of connecting conduits.
- .3 Ceiling outlet boxes to be provided for each surface mounted fixture or row of fixtures installed in other than T bar ceilings with removable tiles.
- .4 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of construction material. Remove upon completion of work.
- .5 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm [0.25"] of opening.
- .6 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers not to be used.
- .7 All outlet boxes to be flush mounted in all areas, excluding mechanical rooms, electrical rooms, and above removable ceilings.
- .8 Adjust position of outlets in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes. All cutting of masonry work for installation of electrical fittings to be done using rotary cutting equipment.
- .9 No sectional or handy boxes to be installed.
- .10 Provide vapour barrier wrap or boots behind outlets mounted in exterior walls. Maintain integrity of the vapour barrier and insulation to prevent condensation through boxes.
- .11 Coordinate location and mounting heights of outlets above counters, benches, splash-backs and with respect to heating units and plumbing fixtures. Coordinate with architectural details.
- .12 Outlets installed back to back in party stud walls to be off-set by one stud space.
- .13 Back-boxes for all communications systems equipment to be provided in accordance with

specific manufacturer's recommendations and as specified in the communications sections of these specifications.

- .14 Separate outlets located immediately alongside one another to be mounted at exactly the same height above finished floor. Similarly, outlets mounted on a wall in the same general location at varying heights to be on the same vertical centre-line unless otherwise noted.
- .15 Where outlet boxes penetrate through a fire separation, ensure that the boxes are externally tightly fitted with an approved non-combustible material to prevent passage of smoke or flame in the event of a fire.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 REFERENCES

- .1 All conduits and accessories to be manufactured and certified by the related CSA standard.

1.4 SCOPE

- .1 Drawings do not show all conduits. Those shown are in diagrammatic form only.
- .2 Conceal all conduits where possible in finished areas. Conduits may be surface mounted either only where indicated or in service areas accessible only to authorized personnel.
- .3 If a finished area is concrete (existing) or concealment is not practical, obtain ruling from Consultant where exposed raceway system may be substituted.
- .4 Note particular requirements for routing of conduits where detailed.
- .5 Provide polypropylene pull cord in all “empty” conduits.

Part 2 Products

2.1 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No.45 Galvanized Steel.
- .2 Epoxy coated conduit: to CSA C22.2 No.45 with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical Metallic Tubing (EMT): to CSA C22.2 No.83.
- .4 Rigid PVC conduit: to CSA C22.2 No.211.2.
- .5 Flexible metal conduit: to CSA C22.2 No.56 liquid-tight flexible metal conduit.

2.2 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 41mm [1.5”] and smaller. Use two hole steel straps to conduits larger than 41mm [1.5”].
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits.
- .4 10mm [3/8”] threaded rods to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings manufactured for use with conduits specified. Coating same as conduit.
- .2 Provide factory "ells" where 90 degree bends are required for 27mm [1”] and larger conduits.

- .3 EMT couplings and connectors shall be steel, or Regal Die-cast zinc alloy. Couplings used on conduit containing fire-rated cable shall be steel. Regular die-cast alloy fittings and couplings are not acceptable. Provide plastic bushings (insulated throat) for all connectors unless there is no chance of burrs. Provide water-tight connectors in damp or wet locations and for surface equipment (e.g. Panelboards, MCC's, etc) in rooms that are fire sprinkler protected.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable linear expansion.
- .2 Water-tight expansion fittings: with integral bonding jumper, suitable for linear expansion and 21mm [3/4"] deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel as required.

2.5 RIGID P.V.C. CONDUIT

- .1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride as manufactured C.G.E. "Sceptre".
- .2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.
- .3 Solvent: as recommended by conduit manufacturer.

Part 3 Execution

3.1 INSTALLATION - GENERAL

- .1 Generally use electrical metallic tubing (EMT) in the building interior and in above grade slabs except where subject to mechanical injury or where otherwise indicated.
- .2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. Set out the work and coordinate with other services prior to installation. Maintain access to junction and pull boxes.
- .3 Where practical conceal conduits.
- .4 Any exposed conduit in finished areas to be free of unnecessary labels and trade marks.
- .5 All conduit ends to be reamed to ensure a smooth interior finish that will not damage the insulation of the wiring.
- .6 Ensure grounding continuity in all conduit systems.
- .7 Surface conduits are acceptable in mechanical and electrical service rooms and in unfinished areas or where indicated.
- .8 Use rigid galvanized steel (RGS) threaded conduit where the installation is subject to mechanical injury. In any event, use RGS conduit for surface installations up to 1.5m [5'] above the finished floor.
- .9 Field threads on rigid conduit shall be sufficient length to draw conduits ends together.
- .10 Unless otherwise noted and where practical, all conduits to be routed through the ceiling space rather than in, or below, slabs or floor structures to facilitate future changes.
- .11 Conduits in walls should typically drop (or loop) vertically from above to better facilitate future renovations. Generally conduits from below and horizontal conduits in walls and concrete structures should be avoided unless indicated.
- .12 All home-run branch circuit conduit and communication/data conduits to be minimum 21 mm [3/4"] diameter unless otherwise indicated.

- .13 Generally use Rigid PVC conduits in or below ground level slab unless otherwise noted. Transition to RGS conduit in exposed locations: eg where conduits emerge from ground level slab.
- .14 Conduits are not permitted in terrazzo or concrete toppings.
- .15 Cap turned up conduits to prevent the entrance of dirt or moisture during construction.
- .16 Locate conduits more than 75mm [3"] parallel to steam or hot water lines with a minimum of 25mm [1"] at crossovers.
- .17 Bend conduits cold, so that conduit at any point is not flattened more than 1/10th of its original diameter. Conduits bent more than this or kinked to be replaced.
- .18 Provide polypropylene pull cord in empty conduits to facilitate pulling wiring in future.
- .19 Where conduits become blocked, the use of corrosive agents is prohibited. Remove and replace blocked section.
- .20 Damaged conduits to be repaired or replaced.
- .21 Dry conduits out thoroughly before installing wiring. Swab out conduit and thoroughly clean internally before wires and cables are pulled.
- .22 Conduits shall not pass through structural members except as indicated.
- .23 Conduit sizes indicated on drawings are minimum only. Increase sizes as required to suit alternative wiring types or to comply with Code.
- .24 Conduits and ducts crossing building expansion joints shall have approved conduit expansion fittings to suit the type of conduit used.
- .25 Seal conduits with approved sealant where conduits are run between heated and unheated areas.
- .26 Seal openings with approved sealant where conduits, cables, or cable trays pierce fire separations.
- .27 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits are installed, wall openings shall be closed with material compatible with the wall construction and/or to meet any fire separation integrity.
- .28 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.
- .29 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of standard boxes where box support is not provided.
- .30 Provide necessary roof jacks or flashing where conduits pass through roof or watertight membranes. Apply approved sealant to maintain membrane integrity.
- .31 Use flexible metal conduit for connection to recessed incandescent fixtures without a prewired outlet box and connection to recessed fluorescent fixtures.
- .32 Use liquid tight flexible metal conduit for connection to motors, and other vibrating equipment and transformers.
- .33 Use explosion proof flexible connection for connection to explosion proof motors.
- .34 Install conduit-sealing fittings in hazardous areas, isolation rooms and clean rooms. Fill with compound.

3.2 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with minimum 1.5m [5'] clearance.

- .3 Conduits to be run in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended and/or surface channels.
- .5 Surface conduits will not be accepted in finished areas unless detailed.

3.3 SPARE CONDUITS

- .1 Provide spare conduits as indicated.
- .2 Provide 4x27 mm [1"] spare conduits up to ceiling space and 2x27 mm [1"] spare conduits down to ceiling space below from each flush panel tub. Terminate the conduits in 150x150x100 mm [6"x6"x4"] junction boxes in ceiling spaces or in case of an exposed concrete slab, terminate each conduit in a flush concrete box. Provide cover plates for all junction boxes.

3.4 CONDUITS IN CAST IN PLACE CONCRETE

- .1 Locate conduits to suit reinforcing steel. Install in centre third of slab.
- .2 Do not place conduit in concrete slabs in which slab thickness is less than four times conduit diameter. Place conduits larger than this size under the floor or slab. Conduits to have minimum 25 mm concrete cover. Conduits to be completely encased in concrete
- .3 Organize conduit in slabs to minimize crossovers. Obtain approval and minimum concrete cover required from structural engineer prior to installing conduits in slabs.
- .4 Protect conduits from damage where they stub out of concrete.
- .5 Tie down conduit to prevent shifting. All joints are to be made up tight to ensure ground continuity. To prevent concrete entry, seal EMT set screw fittings with tape, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 150 mm [6"] at the point of leaving slab.
- .6 Carefully check and mark out set-backs of conduit(s) to be installed in floor slabs and to be stubbed up to equipment or motors. Verify conduit size and stub-up locations for mechanical and equipment from shop drawings or detail drawings. Brace all stub-ups. Stub-ups shall be RGS.
- .7 Install sleeves in advance of concrete pour where conduits pass through slab or wall.
- .8 Where conduits pass through waterproof membrane provide oversized sleeve before membrane installation. Use cold mastic between sleeve and conduit.

3.5 CONDUITS IN POURED SLABS ON GRADE

- .1 Use Rigid PVC conduit in the gravel or select fill base below concrete slabs. Provide mechanical protection around exposed stub-ups through slab and extend up to 150 mm [6"] beyond concrete. Transition to RGS conduit immediately above the slab.
- .2 In the event that rigid steel conduit is installed in contact with earth it shall be protected by Polykin #940 tape. Extend taping 300 mm above finished grade.
- .3 Conduits 27mm and larger to be run below slab and encased in 75mm concrete envelope. Provide 50mm of sand over concrete envelope below floor slab.

3.6 EXPANSION JOINT CONDUIT FITTINGS

- .1 Provide conduit expansion joint fittings at concrete expansion joint.

3.7 RIGID P.V.C. CONDUIT

- .1 Use in accordance with the Canadian Electrical Code and Building Codes and as noted below:

- .2 Use as raceways for following applications
 - .1 In poured slab on grade concrete floors and walls and for underground runs exterior to the buildings unless otherwise noted.
 - .2 Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.
 - .3 Rigid PVC conduit shall not be surface mounted or exposed within buildings.
- .3 Do not use in return air plenums or for exit light circuits and emergency lighting.
- .4 Provide insulated ground wire in all rigid PVC conduits in accordance with the Canadian Electrical Code.
- .5 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions before pour.
- .6 Bend rigid conduit in strict accordance with manufacturer's directions. Distorted bends will not be accepted.

3.8 CONDUIT SIZE REFERENCE

- .1 The following schedule has been included to clarify conduit dimensions used throughout these specifications and on the drawings.

Imperial Standard Size	Common Metric Size	CEC Metric Designation
3/8"	10 mm	12 mm
1/2"	12 mm	16 mm
3/4"	19 mm	21 mm
1"	25 mm	27 mm
1 1/4"	32 mm	35 mm
1 1/2"	38 mm	41 mm
2"	50 mm	53 mm
3"	75 mm	78 mm
4"	100 mm	103 mm

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.1 No.126.1, Metal Cable Tray Systems.
 - .2 CAN/CSA C22.1 No.126.2, Non Metallic Cable Tray Systems.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA FG 1, Fibreglass and Cable Tray Systems.
 - .2 NEMA VE 1, Metal Cable Tray Systems.
 - .3 NEMA VE 2, Cable Tray Installation Guidelines.

1.4 SUBMITTALS

- .1 Provide submittals in accordance with Division 01 - Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.
- .3 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.
- .4 Identify types of cable trays used.
- .5 Show actual cable tray installation details and suspension system.

Part 2 Products

2.1 CABLE TRAY (COMMUNICATION ROOM)

- .1 A steel basket type cable tray shall be provided above equipment cabinets and around the perimeter of the room and shall be attached to the Communications cable tray infrastructure. Refer to drawings for details.
- .2 The tray shall be mounted @ 2.7M AFF unless otherwise noted.
- .3 Wall mounted tray brackets shall be bolted through any plywood backboards to the wall.

2.2 CABLE TRAY (INTERIOR PATHWAYS)

- .1 Provide aluminum cable tray, complete with angles, offsets, corners, saddles, tees, etc. as indicated and required to suit the installation. Radii on fittings shall be 300mm minimum.
- .2 All tray shall have 45 degree corners at all vertical and horizontal corners, tees and width change locations.
- .3 Cable tray to have a minimum cable loading depth of 114mm [4.5"]. Cable tray width to be a minimum of 305mm [12"] wide for communications, or as indicated on drawings

- .4 Suspended tray supports to be trapeze style hangers of minimum 40mm [1.5"] square "Unistrut" supported from 9.5mm [3/8"] threaded rod hangers from preset or afterset concrete inserts or direct steel support.
- .5 Barriers where specified, to be continuous metal dividers for entire length of the tray.
- .6 Fire Barrier Pillows to be self contained intumescent firestop product for use in through-penetration firestops. Product to achieve up to three (3) hours fire rating in accordance with ASTM E 814 tests.

2.3 CABLE TROUGH

- .1 Cable troughs and fittings: to NEMA FG 1/VE 1 and CAN/CSA C22.1 No. 126.1/2.
- .2 Ladder Ventilated & Non Ventilated wire mesh type, Class A C1 to CAN/CSA C22.2 No.126.1/2.
- .3 Solid covers for complete cable trough system including fittings.
- .4 Barriers where different voltage systems are in same cable trough.
- .5 Ground cable trays with bare copper conductor attached to each tray section in accordance with CEC requirements.
- .6 Provide fire stop material at firewall penetrations.

2.4 SUPPORTS

- .1 Provide splices, supports for a continuously grounded system as required.

2.5 STANDARD OF ACCEPTANCE

- .1 Code Manufacturing
- .2 T&B
- .3 Cooper
- .4 Approved equivalent

Part 3 Execution

3.1 GENERAL INSTALLATION – POWER & COMMUNICATIONS

- .1 Cable trays are installed in the false ceiling space of hallways and located to keep conduit lengths to a minimum.
- .2 Provide cable tray in approximate location and general routing as shown on drawings.
- .3 Provide dropouts when cables exiting all horizontal cable trays.
- .4 Support suspended cable tray from trapeze style hangers with hangers spaced as recommended by the manufacturer based on a maximum load capacity for the tray. Support trays at all corners, offsets and tee fittings
- .5 Where shown and appropriate, support cable tray from wall using a cantilever support arrangement. Cable trays may be supported using wall mounted support on masonry walls or from the building steel only.
- .6 Generally Cable Trays shall be separated at a minimum 450mm from the adjacent wall unless otherwise indicated.
- .7 Cable tray location and mounting heights to be coordinated on site with other trades to provide minimum headroom and serviceability. Verify drawing details to allow for all services run in ceiling spaces. Provide vertical and horizontal offsets as required to suit job site conditions.

- .8 Cable tray sections shall be joined by approved connector plates and rust-resistant (plated) hardware. Torque all hardware as per manufacturer's recommendations.
- .9 Unless otherwise indicated, bond all cable tray with a minimum #6 AWG copper bonding conductor installed continuously within the full length of all cable trays. Securely connect the bond wire to the tray at each end and at a minimum of 15m [50'] intervals. Connect bonding conductor to the building ground system at one or both ends.
- .10 Provide pulleys and rollers to install cables.
- .11 Install ventilated type tray in corridors and as vertical risers. Where cable trays pass through solid walls and floors, trays shall be solid type with cover and shall extend a minimum of 450 mm on each side of the wall or floor.
- .12 Where cable tray passes through fire separations install fire pillows as required to maintain proper fire rating.
- .13 Cable tray may require installation of risers, bend, etc. to adjust tray up or down as well as sideways for the tray routing to fit within limits of space available, and to clear other services, ducts, pipes etc. along the route. Routing maybe adjusted somewhat as necessary to enable installation of services under other trades. These field adjustments are to be done at no extra cost to the Owner.
- .14 Where tray runs change elevation, trays shall overlay each other when manufactured waterfall assemblies can not be used. To prevent cables stress install drop-outs on the top tray when overlap method is to be used. Further, tray sections shall be coupled together to provide some rigidity. This coupling maybe made by using a short length of tray and adjustable elbows or may be coupled by means of common support rods at the tray overlap.
- .15 Sharp metal edges in cable trays which could cut the cable shall be smoothed and the cable dressed away from these edges. Manufacturer surface imperfections shall be touched up with a cold galvanizing coating before installing cable.
- .16 There shall be no wiring joints or splices within the cable tray.

3.2 **INSTALLATION - COMMUNICATIONS**

- .1 Cables shall be secured in place in tray with tie wraps where in horizontal runs and with cable clamps in vertical runs. Low tension cabling shall be secured to tray by use of Velcro style straps. Support cables routed vertically through a service riser with a basket type wire grip equal to Hubbell Kellems grip for power cables and data cables including fiber optic cables.
- .2 The "communications" cable tray system is for extra-low voltage cabling only. There shall be no cables within the tray that has a voltage exceeding 30V.
- .3 Power distribution conduits shall not be located within 200mm [8"] of the cable tray.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI C39.1, Requirements, Electrical Analog Indicating Instruments.
- .2 Canadian Standards Association, (CSA International)
 - .1 CAN3-C17, Alternating - Current Electricity Metering.

1.3 QUALITY REQUIREMENTS

- .1 All meters to be "Revenue Grade".
- .2 Refer to single line diagram notes and details.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 00.
- .2 Shop drawings to include system riser diagrams and all connections.

Part 2 Products

2.1 GENERAL METERING SYSTEM REQUIREMENTS

- .1 The meter equipment to be capable of remote communication compatible with the BMS Building Management System.
- .2 Provide a BAC Net software package for meter reading, data storage and generating billing information including printed reports.
- .3 System to have backup storage power so that no data is lost during power outages. The system shall continue to function after resumption of power. Data to be retained for 8500 hours with a 20-year shelf life.
- .4 Failure of the building electrical normal power system shall not result in loss of data and will not require manual restarting of the metering system.
- .5 Refer to single line diagram notes and details.

2.2 MINIMUM SYSTEM MEASUREMENTS

- .1 Meters to be complete with a Liquid Crystal Display (LCD) to access all billing measurements and phase diagnostics.
- .2 Billing Parameters:
 - .1 kWhr poly phase standard
 - .2 kW average demand
 - .3 kVARH reactive consumption
- .3 Phase Diagnostics: Parameters to be displayed for each metered load:
 - .1 Voltage Phase to Neutral for each phase.
 - .2 Amps Instantaneous amperage for each phase
 - .3 Hz Frequency
 - .4 kW Instantaneous real energy

- .5 kVA Instantaneous apparent energy
- .6 kVAR Instantaneous reactive energy
- .7 PF Instantaneous power factor
- .8 Pa Phase angle
- .4 Data Logging:
 - .1 Logging of kW, kVA, kVAR, Total Harmonic Distortion, Sags & Surges, Event Anomalies, Power Factor and Amperage in customized intervals (5,15, 30, 60 minute)

2.3 METERING INSTRUMENT CABINETS

- .1 Integral with switchgear or
- .2 Sheet steel CSA enclosure finish painted.

2.4 TEST TERMINAL BLOCKS

- .1 Test terminal blocks: as required.

2.5 SHOP INSTALLATION

- .1 Switchboard Installation: Install meters and instrument transformers in separate compartment of switchboard.
- .2 Ensure adequate spacing between current transformers installed on each phase.
- .3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources, electrical supplies.

2.6 SOFTWARE

- .1 Software shall be "Windows" compatible and able to export meter data into database and spreadsheet programs.
- .2 Software shall be capable of providing locked levels of access to various users.

Part 3 Execution

3.1 METERING INSTALLATION

- .1 Install meters and instruments in location free from vibration and shock.
- .2 Make connections in accordance with diagrams.
- .3 If applicable, ensure power factor corrective equipment connected on load side of meter.
- .4 Connect meter and instrument transformer cabinets to ground.

3.2 FIELD VERIFICATION, ACCEPTANCE & TRAINING

- .1 Provide "Record Drawings" indicating each meter, serial no., address and CT ratio.
- .2 The equipment manufacturers representative to verify, adjust and test the system.
- .3 Demonstrate operation of the system including software.
- .4 Issue a "CERTIFICATE OF ACCEPTANCE".

3.3 FIELD QUALITY CONTROL

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results – Electrical and in accordance with manufacturer's recommendations.
- .2 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.

- .3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.
- .4 Perform tests to obtain correct calibration.
- .5 Do not dismantle meters and instruments.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results for Electrical.
- .2 Section 26 27 26 Wiring Devices
- .3 Section 26 24 16 Panelboards

1.3 REFERENCES

- .1 American National Standards Institute/Institute of Electrical and Electronic Engineers
 - .1 C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 ASTM International
 - .1 D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight.
- .3 Canadian Standards Association
 - .1 C22.1-15, Canadian Electrical Code, Part I.
 - .2 CSA C22.2 # 14 Industrial Control Equipment
 - .3 CSA C22.2 # 184 Solid-State Lighting Controls
 - .4 CSA C22.2 # 156 Solid-State Speed Controls
- .4 International Electrotechnical Commission
 - .1 (IEC) 801-2 Electrostatic Discharge Testing Standard.
 - .2 IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- .5 International Organization for Standardization
 - .1 9001:2000 – Quality Management Systems.
- .6 National Electrical Manufacturers Association
 - .1 WD1 (R2005) - General Color Requirements for Wiring Devices.
- .7 Underwriters Laboratories, Inc.
 - .1 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - .2 508 (1999) - Standard for Industrial Control Equipment.
 - .3 1472 (1996) - Solid-State Dimming Controls.
 - .4 924 (2003) - Emergency Lighting and Power Equipment.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 - Construction/Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.5 SYSTEM OVERVIEW

- .1 The following specification details the minimum compliance and related criteria for a complete and fully operational wired digital addressable Lighting Control System (LCS) for all interior and exterior lights as indicated on drawing.
- .2 The LCS shall be interfaced to the central Building Management Control System (BMCS).
- .3 The deployment team, contractor and manufacturer, shall provide, connect and furnish all equipment necessary for the proper and complete operation and service of the LCS as indicated in the engineering drawings and specified herein.
- .4 Lighting control system shall utilize networking technology and shall be able to operate as a stand-alone entity with the option of using a web server device or the building BMS system so that programming and viewing of status can be accomplished by any PC connected to the same LAN or via the internet.
- .5 The LCS is to include:
 - .1 Control Devices
 - .1 Distributed dimming control systems
 - .2 Central dimming control system
 - .3 Lighting Control Panels (LCP) – Area Controllers
 - .4 DMX Controllers
 - .2 Input Devices
 - .1 Occupancy, vacancy sensors
 - .2 Sensor power packs
 - .3 Daylight sensors
 - .4 Multi Sensors
 - .5 Touchscreens
 - .6 Wallstations
 - .7 Patient Bedside Controllers (“Pillow Speakers”)
 - .3 End Devices
 - .1 Relays
 - .2 Digital to Analog converters (DAC)
 - .3 0-10V to Reverse phase converters
 - .4 LED drivers
 - .4 Software and Integration
 - .1 BMS integration
 - .2 LAN/VLAN integration
 - .3 Partition controls
 - .4 DMX integration
 - .5 ASCII integration
 - .6 Programming software
 - .7 Emergency lighting control

1.6 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 26 05 00.
- .2 Specification Conformance Document: Indicate whether the submitted equipment:
 - .1 Meets specification exactly as stated.

- .2 Meets specification via an alternate means and indicate the specific methodology used.
- .3 Shop Drawings are to include:
 - .1 Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
 - .2 Schematic of system.
- .4 Product Data: Catalog specification sheets with performance specifications demonstrating compliance with specified requirements.
- .5 Project Record Documents: Installer to record actual installation location and settings of Lighting Control Panels (LCP) and components.

1.7 CLOSEOUT SUBMITTALS

- .1 Lighting control system manufacturer to provide an operation and maintenance manual that details the start-up procedure being performed including a process to follow, details on tests performed and an area that documents any test results.

1.8 COORDINATION REQUIREMENTS

- .1 Coordination
 - .1 Coordinate the placement of area controllers/lighting control panels and dimming panels
 - .2 Coordinate the placement of sensors, wallstations and other user input devices
 - .3 Coordinate the placement of daylight sensors to achieve optimal daylight dimming
- .2 Prewire meeting: Conducted on-site with lighting control system manufacturers or designated representative prior to commencing work as part of the manufacturer's standard practice and startup services. Manufacturer to review with the installer:
 - .1 Installation of area controllers, dimming panels and locations
 - .2 Lighting control network wiring
 - .3 Network IT requirements
 - .4 Low voltage wiring requirements
 - .5 Lighting control integration requirements
 - .6 Lighting control system integration network wiring and connectivity
 - .7 Installer responsibilities
 - .8 Startup and training schedule and actions

1.9 DELIVERY, STORAGE, AND HANDLING

- .1 Ensure products are delivered as shipped, including pallet assembly and packaging has not been damaged in shipment.
- .2 Store products in a clean, dry location in manufacturers original packaging.
- .3 Store products in an environment that meets products ambient and storage temperature per products specification sheets.
- .4 Store products in an environment that meets products relative humidity of less than 90 percent, non-condensing as outlined on the product specification sheets.

1.10 PROJECT CONDITIONS

- .1 Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - .1 Ambient temperature: 0° to 40° C (32° to 104° F).

- .2 Relative humidity: Maximum 90 percent, non-condensing.
- .2 Lighting control system must be protected from dust and sprays during installation.
- .3 Coordinate layout and installation of luminaries and controls with other construction.
- .4 Coordinate site commissioning with manufacturer no less than 30 days prior to substantial completion date.

1.11 QUALITY ASSURANCE

- .1 Product shall conform to requirements outlined in CSA C22.1:21.
- .2 Manufacturer: Minimum 10 years experience in manufacture of architectural lighting controls.
- .3 Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
- .4 Central dimming control system:
 - .1 Meets cUL, and CSA Standards specifically for the required loads. Provide evidence of compliance upon request.

1.12 WARRANTY

- .1 Provide manufacturer's enhanced 5-year limited warranty:
 - .1 5-year limited warranty for the replacement of defective system components from the date of system shipment (except software application).
- .2 Contractor shall provide limited workmanship warranty for one year from customer acceptance.
- .3 Extra Materials:
 - .1 Multi-sensors: provide 5 spare DALI multi-sensors and 5 spare CAN bus multi-sensors, to be used for maintenance.
 - .2 Wallstation: provide 5 spare wallstations of each type (button quantity) used, unlabeled, to be used for maintenance.
 - .3 Field Relay: provide 10 extra field relays, to be used for maintenance.
 - .4 DAC: provide 5 extra DAC modules, to be used for maintenance.

1.13 COMMISSIONING

- .1 Provide factory-certified field service engineer to a site visit to ensure proper system installation and operation under following parameters:
 - .1 Factory-certified field service engineer to be certified by the equipment manufacturer on the system installed.
- .2 Make a visit upon completion of installation of central dimming control system:
 - .1 Verify connection of power feeds and load circuits.
 - .2 Verify connection Wallstation controls.
 - .3 Verify proper connection.
 - .4 Download system data to controllers and devices.
 - .5 Check dimming panel load types and currents and remove by-pass jumpers.
 - .6 Verify system operation control by control, circuit by circuit.
 - .7 Obtain sign-off on system functions.
 - .8 User to be trained on system operation.
- .3 Conclude commissioning with:

- .1 Verify system control operation area by area.
- .2 Obtain sign-off on system functions.
- .3 User to be trained on system operation.
- .4 Include for one additional follow-up visit after building occupancy to:
 - .1 Provide additional user training.
 - .2 Verify system continuous commissioning and control
 - .3 Provide troubleshooting and/or suggestions for controls improvement

1.14 MAINTENANCE

- .1 Make ordering spare parts available to end user.
- .2 Make new replacement parts available for minimum of ten years from date of manufacture.
- .3 Provide factory direct technical support hotline.
- .4 Provide on-site service support where required.
- .5 Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits to customer if desired.

1.15 SYSTEM DESCRIPTION AND OPERATION

- .1 The wireless lighting control system shall be capable of providing all of the following functions for all lighting:
 - .1 Continuous dimming and automatic on/off controls.
 - .2 DMX input and output controls.
 - .3 Forward and reverse phase output controls.
 - .4 Indoor (low and hi bay) occupancy control.
 - .5 Indoor vacancy control.
 - .6 Indoor (low and hi bay) daylight harvesting.
 - .7 Outdoor load control.
 - .8 Receptacle control.
 - .9 Load management.
 - .10 Partition control.
 - .11 Multi-level scene control.
 - .12 7-Day scheduling.
 - .13 Astronomic scheduling.
 - .14 Demand Response.
 - .15 Task Tuning.
 - .16 Mobile device scene setting and control.
 - .17 Integration with and control of motorized blind systems.
 - .18 Integration with third party systems via BACnet/IP and Public (REST) API.
 - .19 Alarms monitoring console.
- .2 The wired connected lighting control system shall be capable of continuous dimming and switching allowing individual fixture and/or zone control to monitor its local environment and provide distributed control in response to environmental changes.

- .3 The wired connected lighting control system shall provide network communication of all sensor and device data for all wired devices on the local bus, providing occupied/unoccupied status, scene status and daylight information.
- .4 The wired connected lighting control system shall provide a method for the installer to verify the local bus communications and address all devices on the local bus.
- .5 Centralized dimming control system – Factory assembled dimming and switching solutions that allow for applications to scale from small to enterprise while providing simplified low voltage wiring to allow for system completion faster. This system includes third party integration and features to simplify complex application designs.
- .6 Occupancy Sensors – PIR, DT, NEMA WD7 compliant occupancy or vacancy sensors.
- .7 Wallstations – Smart device that are fully programmable, pre-engraved digital pushbutton wallstations and dimmers.
- .8 Scene Wallstation – Smart device that are fully programmable, pre-engraved digital pushbutton scene wallstations, dimmers and programmable scene buttons.
- .9 Daylight Photosensor – Smart device that is a multi-zone open loop daylight sensor with two-way active infrared (IR) communications, which can provide dimming control for daylight harvesting.
- .10 Touchscreens – Full color touchscreen that can be programmed to control any area on the lighting control network. Shall include multiple screens with templates for simplified programming as well as password protected screen locking features.
- .11 Partitioning – Simplified or complex partition control that allows room and control join mechanisms via button press, key switch, or IR wall close sensors.
- .12 3rd Party Integration – Interface shall be provided to allows for 3rd party integration via serial or Ethernet into the LCS using standard ASCII commands or a Public (REST) API.
- .13 Integration to motorized blind system – Coordinate with blind supplier and provide all interface and control modules require to control blinds using DALI wallstation controls. Each motorized blind to be provided with DALI address.
- .14 BMS Integration – BACnet interface shall be available to allow BMS systems to detect and control area status.
- .15 Demand Response – OpenADR or other demand response input shall be connected to one or more LCP. The DR signal will trigger a response to the lighting and is fully programmable based on a single area or the entire network.
- .16 Communication network wiring - Belden 1502 or 1502P network wire to daisy chain the LCP throughout the system.
- .17 Local bus - 2 wire topology free polarity free low voltage network –14AWG twisted pair wire (purple and purple) for connecting user interface devices to the LCP.

1.16 LIGHTING CONTROL APPLICATIONS

- .1 Occupancy/vacancy requirements – provide an occupancy/vacancy sensor with manual on/ automatic off or automatic on/ automatic off functionality in spaces indicated on drawings and on lighting control schedule. Manual on vacancy sensors should be used for any enclosed space with a manual on switch that does not require hands free operation. Systems that do that allow the user to select occupancy or vacancy mode shall not be acceptable.
- .2 Bi-level switching – provide multi-level switching and/or variable dimming.

- .3 Task lighting / receptacle control – provide automatic shut off of non-essential plug loads and task lighting as indicated on drawings. Receptacle control will only be shut off when no occupancy is detected within the space. Systems that do not provide receptacle control for a full 20 amp circuit shall not be acceptable.
- .4 Daylight zones – primary sidelit or toplit areas within an enclosed space shall be controlled separately and automatically by individual integrated daylight sensors. Adjustments to the daylight zones must be provided by a simple to use, intuitive mobile application.
- .5 Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to dim electric light to the lowest light level and off.
- .6 Provide the ability to adjust the high-end and low-end trim of the dimmers to ensure the lighting automatically provides energy saving even when daylighting calls for full illumination.
- .7 Provide the ability for the dimmers and the relays to function separately.
- .8 Shall be capable of automatically responding to a demand response signal and adjusting the lighting level.
 - .1 Egress lighting control shall be integral to the system. The system shall provide an automatic control of adjacent corridor and/or egress lighting based upon room occupancy. Systems that do not ensure that adjacent corridor and/or egress lighting is controlled with room occupancy shall not be acceptable.
 - .2 Shall be able to communicate with third party system such as a building automation system by means of native BACnet/IP communication hosted on the supervisory system. The supervisory system shall be on the same subnet as the third-party system.

Shall be able to communicate with third party systems such as IoT platforms or AV systems by means of restful API commands via the public API interface hosted on the supervisory system. The supervisory system shall be able to communicate to the third system via the IP network provided by the customer through the proper ports.

1.17 CYBERSECURITY

- .1 The network connectable products within the LCS must include an industry cybersecurity plan and publicly available statement of best practices. Lighting Control Systems that fail to meet this requirement will not be accepted.
- .2 The enterprise connectable products within the LCS must be UL2900-1 listed to the Standard for Software Cybersecurity for Network-Connectable Products. LCS that fail to meet this requirement will not be accepted.

Part 2 Products

2.1 MANUFACTURERS

- .1 Basis of design product: Cooper Lighting Solutions WaveLinx Wired Connected Lighting system
- .2 Equivalent systems from other suppliers may be proposed as substitutions to the above listed product, subject to compliance with specified requirements of this section. Equal systems must be submitted for approval during the bid period.
- .3 Substitutions:
 - .1 All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the consultant a minimum of 10 working days prior to the bid date and must be made available to all bidders.
 - .2 Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
 - .3 By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring.
- .4 Provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 GENERAL

- .1 Provide system hardware that is designed, tested, manufactured, and warranted by a single manufacturer.
- .2 Architectural Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0° C (32°F) to 40° C (104°F) and 90 percent non-condensing relative humidity.
- .3 Designed and tested to withstand electrostatic discharges up to 12,000 V without impairment per IEC 801-2.

2.3 IOT SERVERS

- .1 Trellix Core TRX-TCPRO2
 - .1 Each Trellix Core model shall communicate to a defined to one EG2.
 - .2 The entry level model (Trellix Core Pro) shall support up to 20 Wireless Area Controllers
 - .3 The Trellix Core shall support all Trellix Connected Applications and 3rd party interfaces (BACnet/IP, REST API, OpenADR).
 - .4 The Trellix Core shall be a UL-2900 listed product where UL-2900 is a standard Cybersecurity for Network Connectable Products.

2.4 LIGHTING CONTROL PANELS (AREA CONTROLLERS)

- .1 Mechanical:
 - .1 Meets CSA Standards specifically for the required loads. Provide evidence of compliance upon request.
 - .2 Delivered and installed as a factory assembled panel listed to UL508.
 - .3 Field wiring accessible from front of panel without need to remove dimmer or relay assemblies or other components.
 - .4 Area Controllers passively cooled via free-convection, unaided by fans or other means.

- .2 Electrical:
 - .1 Electrolytic capacitors to operate under the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40° C (104° F) ambient temperature.
 - .2 Design and test dimmers/relays to withstand line-side surges without impairment to performance.
 - .1 LCP and Dimming Panels: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41 and per IEC 61000-4-5 surge requirements.
 - .2 Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41.
 - .3 Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.
 - .4 Power failure memory and dimmer/relay recovery:
 - .5 When power is interrupted and subsequently returned, lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption.
 - .6 In 3 phase Dimming Panels loss of power to any phase should not affect operation or control dimmers on any other phase.
- .3 Performance:
 - .1 Shall be UL listed to relevant standards (UL508A, UL916, cULus)
 - .2 Shall be capable of mixed voltages 120/277VAC 50/60Hz
 - .3 Shall be capable of mixed sources including normal and emergency power
 - .4 Shall include a panel SCCR rating of 25kA
 - .5 Shall be capable of providing a mixed module solution panel including relays, dimmers and two wire addressable controls.
 - .6 Shall be capable of meeting the latest IECC, ASHRAE and Title 24 energy codes
 - .7 Shall support three LCP sizes
 - .1 Small LCP
 - .1 Shall support up to two modules
 - .2 Medium LCP
 - .1 Shall support up to four modules and PC connection module
 - .2 Shall include configurations with Ethernet connection to building LAN or VLAN
 - .3 Large LCP
 - .1 Shall support up to eight modules and PC connection module
 - .2 Shall include configurations with Ethernet connection to building LAN or VLAN
- .4 Local bus Module: (SCMD4)
 - .1 Up to 8 Local bus connections in small area controller
 - .2 Up to 16 Local bus connections in medium area controller
 - .3 Up to 32 Local bus connections in large area controller
 - .4 Each local bus module shall support up to four two wire local buses
 - .5 Each local bus shall be polarity and topology free
 - .6 Shall include dedicated test/override buttons for each local bus
 - .7 Shall include a separate power supply for each local bus

- .1 Shall provide 16V nominal, 250mA max current per local bus
- .2 Shall support 64 standard local bus devices per local bus
- .8 Local bus modules shall include the capability for DMX input control with base address
- .9 Local bus module shall include alert dry contact input for hardware override
- .5 Ethernet: (EG2)
 - .1 Shall provide a single ethernet port for connection to the building LAN or VLAN
 - .2 Shall be capable of facilitating a LAN or Wi-Fi connection to the LCS
 - .3 Shall include an integral web server
 - .4 Shall include the capability of network scheduling.
 - .1 EG2 must be connected to a network with a NTP server to ensure accurate system scheduling
 - .2 Scheduling done using the LCS software or via the Trellix Core/IOT Server
 - .5 Shall provide the capability for mobile devices to override the lighting system via scene or channel slider commands
 - .6 Shall provide the capability for 3rd party integration via ASCII control strings
 - .7 Shall provide the capability for bridging the LCS network across LAN or VLAN connections

2.5 INPUT DEVICES

- .1 Wallstations and Touchscreens
 - .1 Product: Wallstation DW-*TSB-RL-*,DW-*TLB-*.
 - .1 Communication: DALI Bus.
 - .2 Power: From the DALI Bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the local bus and the SCMD4 module.
 - .5 Functionality:
 - .1 Upon button press, LEDs to immediately illuminate.
 - .2 Each button shall be programmable to control any area, scene, channel
 - .6 Color: White
 - .7 Provide color matching faceplates with concealed mounting hardware where specified.
 - .8 Engrave wall stations with appropriate button, zone, and scene descriptions as specified.
 - .2 Product: TSE Touchscreens TSE55-B, TSE80-B
 - .1 Communication: LCS wired protocol.
 - .2 Power: PoE
 - .3 Connections: PoE network
 - .4 Sizes:
 - .1 TSE55-B: 5.5" diagonal backlit capacitive LCD touchscreen
 - .2 TSE80-B: 8" diagonal backlit capacitive LCD touchscreen
 - .5 Mounting: Wallbox

- .1 TSE55-B: Single gang standard box (landscape or portrait mounting)
- .2 TSE80-B: Double gang standard box (landscape or portrait mounting)
- .6 1280x800 pixel resolution, 16.7M color
- .7 Shall allow up to 250 pages to be stored in memory
- .8 Groups: The set of fixtures controlled by a given touchscreen shall be completely configurable through software and can span entire LCS network.
- .9 Shall support individual zone level adjustment and save scene controls.
- .10 Requires the TSI-1-NA TSE Touchscreen Interface to connect to the WaveLinx Wired network
- .3 Product: TSE Touchscreen Interface [TSI-1-NA]
 - .1 Communication: LCS wired protocol.
 - .2 Power: LCS Wired Network or Aux 12VDC power supply (optional)
 - .3 Connections: PoE network and WaveLinx Wired network
 - .1 PoE network must be the same network as the TSE Touchscreens
 - .2 Use either static or dynamic IP addresses
 - .3 IP addresses are defined by the site IT coordinator
 - .4 Mounting: Surface mount to wall
 - .5 Shall allow communications from up to 25 TSE Touchscreens to the LCS wired network
- .2 Addressable Multi-Sensor
 - .1 Product: MTS-6, MTS-12, MTS-HB
 - .1 Communication: DALI bus.
 - .2 Power: from the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the local bus and the SCMD4 module.
 - .5 Sensing Technologies: Occupancy, daylight and temperature.
 - .6 Daylight Sensing Range: 0-400 lux.
 - .7 Daylight Sensing Coverage: Light input within 60° cone.
 - .8 Occupancy Detection Technology: Passive infrared.
 - .9 Occupancy Detection Coverage Area: 600 sq. ft. or 1,200 sq. ft.
 - .10 Occupancy Detection Angle: 360°.
 - .11 Mounting: Junction box or ceiling tile.
 - .12 Mounting Height: 8-12ft MTS-6,MTS-12
 - .13 Mounting Height: 40FT MTS-HB
 - .14 Groups: The set of fixtures controlled by a given multi-sensor shall be completely configurable through software and can span LCS network..
 - .15 Timers: All times shall be configurable through the web software and shall not require any manual configuration of settings prior to installation. Timer values can range from 1 second to 24 hours
 - .16 Shall be capable of occupancy forwarding to send occupancy status to other areas within the system

- .3 Dali Bus Addressable Sensor Powerpack
 - .1 Product: SPP-MV-DC2, SPP-MV-DC1, SPP-347-DC2, SPP-347-DC1, SPP-240-DC2, SPP-24-DC1
 - .1 Communication: DALI bus.
 - .2 Power: 120/277VAC
 - .3 Maximum Current Draw: 2 mA.
 - .4 Maximum number of sensors: Up to five (5) PIR or DT sensors are connected and report to the system as a single address.
 - .5 Communications Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the local bus and the SCMD4 module.
 - .6 Sensor Connections: Five (5) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to sensor for controls and addressing.
 - .7 Main Power Connections: Three (3) wire (hot, neutral, ground connections)
- .4 Ceiling Mounted Sensors (Dual Technology OS)
 - .1 Product: OAC-DT-2000-R, OAC-DT-1000-R, OAC-P-1500-R, OAC-U-2000-R.
 - .1 Provide all necessary mounting hardware and instructions.
 - .2 Sensors shall be Class 2 devices.
 - .3 Connect up to five (5) sensor to the DALI Addressable Powerpack for power and signal back to the WaveLinx Wired system
 - .4 Device calibration and features:
 - .1 Sensitivity – 0-100% in 10% increments.
 - .2 Time delay – 1-30, self-adjusts to 10 min based on room occupancy.
 - .3 Test mode – Fifteen second time delay.
 - .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - .5 Walk-through mode.
 - .2 Device Status LEDs including:
 - .1 PIR Detection
 - .2 Ultrasonic detection
 - .3 Manual override of controlled loads.
 - .4 Sensors shall be RoHS compliant.
- .5 Wall Mounted Sensors (Dual Technology OS)
 - .1 Product: OAWC-P-120W-R, OAWC-P-009L-H-R, OAWC-DT-120W-R,
 - .1 Provide all necessary mounting hardware and instructions.
 - .2 Sensors shall be Class 2 devices.
 - .3 Connect up to five (5) sensor to the DALI Addressable Powerpack for power and signal back to the LCS Wired system
 - .4 Device calibration and features:
 - .1 Sensitivity – 0-100% in 10% increments.
 - .2 Time delay – 1-30, self-adjusts to 10 min. based on room occupancy.
 - .3 Test Mode – Fifteen second time delay.

- .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
- .5 Walk-Through Mode.
- .6 Automatically and continually self-adjust ultrasonic frequency to ignore specific frequency continuous noise from airflow to prevent detuning which can lead to inadvertent lights out. Sensors that require detuning shall not be acceptable.
- .5 Device Status LEDs including:
 - .1 PIR Detection
 - .2 Ultrasonic detection
- .6 Manual override of controlled loads.
- .7 Sensors shall be RoHS compliant.

2.6 END DEVICES

- .1 Addressable Relays and Drivers
 - .1 Product: DAC-DC1, DAC-DC2 LED 0-10V Controller
 - .1 0-10V Addressable Dimming Modules
 - .2 Communication: DALI bus.
 - .3 Power: From the DALI bus.
 - .4 Maximum Current Draw: 3.75 mA.
 - .5 Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the WaveLinX Wired local bus and the SCMD4 module.
 - .6 Power Ratings: Up to 4A Ballast/Driver 120/277/347 VAC.
 - .7 Dimming Control: 0-10V, 50 mA max current sink.
 - .8 Mounting: Fixture or conduit (90° elbow and mounting clips included).
 - .9 UL 924 Listed component.
 - .2 Product: HPRS-MV-DC1 Relay Controller
 - .1 Communication: DALI bus.
 - .2 Power: from the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Enclosure: Standard outlet box or NEMA 250, Type 1, unless otherwise indicated.
 - .5 Communication Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the local bus and the SCMD4 module.
 - .6 Relay Ratings: Up to 20 A at 347 VAC.
 - .7 Field relays shall be capable of controlling plug loads.
 - .8 Mounting: Junction box.
- .2 Power Converters
 - .1 Product: LDCM-PL-120-277-010V-GR 0-10V to Reverse Phase Controller
 - .1 Communication: 0-10V
 - .2 Power: 120/277VAC
 - .3 Maximum Current: 450W @ 120V or 1000W @ 277V
 - .4 Shall control ELV loads(reverse phase) based on 0-10V input signal

- .5 Shall provide ON/OFF capability of load through external relay providing power to unit
- .3 Mounting: Junction box

2.7 INTEGRATION AND ACCESSORIES

- .1 BMS Intergration
 - .1 Product: FPA-W34-1130 BMSPro 2 - BACnet Interface
 - .1 The LCS Wired network shall permit data protocol translation through a building automation interface Gateway. The BACnet Gateway shall permit BACnet communication protocol to operate individual areas, scenes or channels and read the status. The LCS network shall respond efficiently to the requested information from the BACnet network.
 - .2 Provide up to 10,000 points of control and can communicate to multiple panel types.
 - .3 The BMSPro 2 requires a dedicated EG2 interface for connectivity either installed in an LCP or as a separate accessory.
 - .4 Provide PIC list (list of all the programmed zones or patterns within the system) definition and object model to other system manufacturers.
 - .2 LAN/VLAN INTEGRATION
 - .1 Product: EG2-NA Ethernet Gateway
 - .1 Shall provide a single ethernet port for connection to the building LAN or VLAN
 - .2 Shall be capable of facilitating a LAN(by others) or Wi-Fi (by others) connection to the LCS network
 - .3 Shall include an integral web server
 - .4 Shall provide the capability for mobile devices to override the lighting system via scene or channel slider commands
 - .5 Shall provide the capability for 3rd party integration via ASCII control strings
 - .6 Shall provide the capability for bridging the LCS network across LAN or VLAN connections including across fiber networks (provided by others)
 - .7 Provide ability for bi-direction communication by means of Ethernet communication to system by means of user-supplied PC, digital audiovisual, or BMS equipment. Control to be located on the same Local Area Network.
 - .3 SERIAL INTEGRATION
 - .1 Product: SI-2-NA RS232 Interface
 - .1 Communication: LCS Wired network.
 - .2 Power: From the LCS Wired network wire.
 - .3 Connections: Five (5) wires Belden 1502 or 1502P
 - .4 Mounting: Junction box
 - .5 Provide ability for bi-direction communication by means of RS232 serial communication to system by means of user-supplied PC, digital audiovisual, or BMS equipment. Control to be located within 50 feet (15 meters) of RS232 source.
 - .6 Allow for custom RS-232 command strings to be entered into software to allow lighting control system to control any other device as required.

- .4 Universal Input Modules – Patient Bedside Controller
 - .1 Product: UIM-NA Universal Input Module
 - .1 Communication: LCS Wired network
 - .2 Power: From the LCS Wired network wire.
 - .3 Connections: Five (5) wires Belden 1502 or 1502P
 - .4 Inputs: Six (6) digitally optically isolated inputs
 - .5 Mounting: Junction box
 - .6 Low Voltage Input: Shall provide the capability for contact closures to integrate between lighting controls and other systems.
 - .1 The contact closure input device will accept both momentary and maintained contact closures.
- .5 DMX INTEGRATION
 - .1 Product: SCD96-NA DMX Output Controller
 - .1 Communication: LCS Wired network.
 - .2 Power: 120VAC
 - .3 Connections: Five (5) wires Belden 1502 or 1502P
 - .4 DMX Connection: Three (3) wire DMX cable (by others)
 - .5 Inputs: Eight (8) digitally optically isolated inputs
 - .6 Relay Outputs: Eight dry contact N.O./N.C.
 - .7 DMX Output: 96 channels of DMX
 - .8 Mounting: Surface
 - .9 Provide the ability to control standard DMX devices such as RGB fixtures, moving lights, dimmers and effects.
 - .10 Provides the ability to map any WaveLinx Wired wall station button to a DMX channel.
- .6 CURTAIN/SHADE INTEGRATION
 - .1 Product: RI-2-NA Relay Controller
 - .1 Communication: LCS Wired network.
 - .2 Power: 120VAC
 - .3 Connections: Five (5) wires Belden 1502 or 1502P
 - .4 Inputs: Eight (8) digitally optically isolated inputs
 - .5 Relay Outputs: Eight dry contact N.O./N.C.
 - .6 Mounting: Surface
 - .7 Provide eight dry contact programmable low power relays to control curtain, shades, AV screens and other equipment.
- .7 NETWORK ACCESSORIES
 - .1 Product: LCNJ
 - .1 Communication: LCS Wired network.
 - .2 Power: From the LCS Wired network wire.
 - .3 Connections: Five (5) wires Belden 1502 or 1502P
 - .4 Mounting: Junction box
 - .5 Shall allow direct access to the lighting control network while in the space being modified.
 - .2 Product: BN-2-NA

- .1 Network Bridge
- .2 Communication: LCS Wired network.
- .3 Power: From the LCS Wired network wire
- .4 Connections: Five (5) wires Belden 1502 or 1502P
- .5 Mounting: Junction box
- .6 Shall allow the network to extend more than 1000m/3200 feet.
- .7 Shall permit the connection of multiple networks allowing up to 65,000 devices on one system.

2.8 COMMISSIONING SOFTWARE

- .1 WaveLinx Wired Software or equivalent software for proposed alternate.
 - .1 Product: SOFT-ILP
 - .1 Software shall support multiple functions to setup entire enterprise WaveLinx Wired system
 - .1 WaveLinx Wired local bus addressing tool
 - .2 Device editor for system programming and scheduling
 - .3 iCANsoft editor for system programming and scheduling
 - .4 Smartphone configuration tool for mobile applications
 - .5 TSE Designer Software
 - .2 Software shall support multiple diagnostic tools for troubleshooting the WaveLinx Wired system
 - .1 Network monitor
 - .2 Flash tool for updating system device firmware
 - .3 Device simulator
 - .3 Shall include with user-friendly software suitable for operation on computer workstations which serve as central control stations for the selection and operation of lighting scenes
 - .4 Clients shall interface with the software via Cooper Lighting Solutions WaveLinx Wired software

2.9 CONNECTED APPLICATIONS

- .1 Trellix Lighting or equivalent application for alternate system.
 - .1 The application shall be accessible via HTML5 compatible web browsers such as Microsoft Edge, Google Chrome and Apple Safari.
 - .2 The application shall support multiple computing device types, i.e. smartphones, tablets, laptops and desktop computers.
 - .3 The software application shall support touch interaction.
 - .4 The application shall utilize HTTPS (industry-standard certificate-based encryption and authentication for security).
 - .5 The system shall display the location of zones and areas on a floor plan (jpeg or svg)
 - .6 The system shall allow users to monitor and control the lights:
 - .1 Area lights can be monitored for on/off status
 - .2 Area lights can be modified to a predefined scene or defined light level
 - .3 Zone lights can be monitored for on/off status
 - .4 Zone lights can be modified to defined light level
 - .7 The system shall allow users to monitor and control the light schedules:

- .1 Display the light schedule on a daily, weekly or monthly calendar
- .2 Configure light schedule based on a specific time of day or astronomic time clock event.
- .8 The system shall display system's fault in near real-time. System faults include loss of communication with the LCS network.
- .9 The system shall log all current and past system faults to provide better insight of the system's health.
- .10 The system shall offer context-sensitive troubleshooting tips for each alarm
- .11 The system shall be able to send e-mail notifications to subscribe users for each fault. The user shall provide the SMTP server information to allow the Trellix Application to send out email notifications.
- .2 BACnet Interface
 - .1 The BACnet/IP interface shall support the following capabilities:
 - .1 BACnet integrator can monitor:
 - .1 Area scene
 - .2 Dimming zone level (0-100%)
 - .3 On/off zone level (on/off)
 - .2 BACnet integrator can command:
 - .1 System-wide Demand Response enable/disable
 - .2 Area scene
 - .3 Dimming zone level (0-100%)
 - .4 On/off zone level (on/off)
 - .2 The system shall be able to allow users to select which object types the system shall expose, i.e. Area, Zones.
 - .3 The system shall be able to generate the electronic PICS document and allow users to be able to send the PICS document to the proper stakeholders.
- .3 The Public API shall support the following capabilities:
 - .1 The Public API interface shall support the following get/put capabilities:
 - .1 Get:
 - .1 Building hierarchy information (areas, zones, devices)
 - .2 Area scene
 - .3 Dimming zone level (0-100%)
 - .4 Zone level (on/off)
 - .2 Put:
 - .1 System-wide Demand Response enable/disable
 - .2 Area scene
 - .3 Dimming zone level (0-100%)
 - .4 Zone level (on/off)
- .4 OpenADR interface shall support the following capabilities:
 - .1 Register the OpenADR interface of the LCS with a utility's Demand Response Automation Server (DRAS)
 - .2 Initiate load shed event using OpenADR protocol in an auto-Demand-Response event without additional interfaces or gateways.

Part 3 Execution

3.1 INSTALLATION

- .1 Install equipment in accordance with manufacturer's installation instructions.
- .2 Provide complete installation of system in accordance with Contract Documents.
- .3 Define each dimmer's/relay's load type, assign each load to a zone, and set control functions.
- .4 Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
- .5 100 digital devices (Source Controllers, User Interfaces, etc) may reside on a single network segment with a network length not to exceed 3000 feet. Additional network segments shall be accomplished by the employment of a network bridge up to 65000 devices. Network segments shall be terminated at the end of each segment.
- .6 Devices to be connected via Daisy Chain topology.
- .7 Network wire recommended is Belden#1502R or 1502P (plenum) or similar. Wire shall meet color code requirements to insure proper installation of the network polarity.
- .8 All area controllers and dimming panels are "masters" and may be added to the network in any location and any amount as long as network installation guidelines are met.
- .9 Area controllers and dimming panels are designed to function independently from external control devices.

3.2 FACTORY COMMISSIONING

- .6 Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.
- .7 The electrical contractor shall provide both the manufacturer and the electrical engineer with twenty-one (21) working days written notice of the system startup and adjustment date.
- .8 Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.
- .9 Qualifications for factory certified field service engineer:
 - .1 Certified by the equipment manufacturer on the system installed.
- .10 Make first visit upon completion of installation of LCS:
 - .1 Verify locations of LCP
 - .2 Identify connected devices and program using Configuration Software.
 - .3 Verify that system operation control based on defined Sequence of Operations (SOO).
 - .4 Obtain sign-off on system functions.
- .11 Make second visit to demonstrate and educate Owner's representative on system capabilities, programming, fine tuning and maintenance.

3.3 CLOSEOUT ACTIVITIES

- .1 Training Visit

- .1 Lighting control system manufacturer to provide one (1) day additional on-site system training to site personnel. This shall be a part of the second visit by field service to the site.
- .2 During this visit, the manufacturer's Field Service Engineer will perform tasks, at the request of the facility representative or Commissioning Agent, such as to demonstrate wall control functions, explain or describe occupancy and/or daylight sensor functionality.
- .3 On-site Walkthrough
- .4 Lighting control system manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent.

3.4 MAINTENANCE

- .1 On-site service support must be available within 72 hours.
- .2 Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten (10) years after date of system startup.
- .3 Provide an on-site meeting between the Lighting Control System Manufacturer and a Facility Representative to evaluate system usage after the building has been in operation for a predetermined period.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 00.

1.3 COORDINATION OF PROTECTIVE DEVICES AND SHORT CIRCUIT STUDY

- .1 This contract includes an addition to an existing power system. The coordination documents to include all the existing power devices upstream and in-line to this installation.
- .2 Provide a system coordination study for review and acceptance by the consultant. The study shall include all devices from the protection devices of the 600V switchgear down to and including the 208V distribution breakers and the largest motor on each 600V and 208V bus. Separate graphs shall be produced for all possible variations of power flow for each phase protection and ground protection.
- .3 Ensure circuit protective devices such as overcurrent trips, relays, and fuses are installed to the required values and settings and further adjusted in accordance with the approved coordination study.
- .4 Provide short circuit study and Arc Flash study. Contractor to measure length of panelboard conductors.
- .5 Include all associated costs in this Division for the preparation of a complete system study that shall include of Protective Coordination, Short Circuit, Ground Fault, and Arc Flush. The base and system short circuit study values, electrical coordination curves and breaker settings to be based on the Utility the Manufacturers information.
- .6 The arc flash study shall analyze the Flash Boundary Distance and the range of incident energy based on the calculated available fault current range at each device. The arc flash analysis, short circuit and coordination study shall be performed using the latest version of SKM system analysis power tools for Windows software, which meets the calculation requirements of IEEE Std 1584a, NFPA 70E, ANSI C.37, and IEEE Std. 399.
- .7 The Coordination Study and Curves to be sealed by a practicing professional engineer registered in the jurisdiction of the project installation. (Province, Territory, State, etc).
- .8 Coordination Study shall be included with the power distribution shop drawings.
- .9 Documentation to include the following:
 - .1 Available symmetrical fault current including Utility and large motor contribution.
 - .2 Symmetrical withstand current rating for bussing.
 - .3 Transformer damage curves and in-rush for the main power transformers and major distribution transformers.
 - .4 Large Motor starting and damage curves.
 - .5 Breaker interrupting capacities including any cascade arrangements.
 - .6 Transfer switch interrupting or withstand capacity as appropriate.
 - .7 Relay information, manufacturer and type, sensor ratings and tap setting, relay pickup and delay settings.
 - .8 Settings for all breakers having adjustable solid state trips or thermal magnetic trips.
 - .9 Single line of system illustrated on curves. All curves to be justified using upstream

- and downstream conditions. Provide alternative scenarios where applicable.
- .10 Submit, with the main distribution switchgear and secondary distribution switchboard general arrangement drawings, a complete set of coordination curves. Coordination curves to be submitted prior to selection of primary fuses, main and secondary air circuit breaker trip settings and ground fault relay pick-up and time delay settings.
 - .11 Coordination curves to include the main primary feeder protective devices in the utility system, the primary fuses in the main switchgear, transformer damage curves, all main and secondary air circuit breakers.
 - .12 Coordination curves to be plotted on log-log graph paper and shall be accomplished by individual time current trip curves of each device.
- .10 The review will not eliminate the responsibility of this Division to provide system coordination and protection.
- .11 Circuit protective devices such as overcurrent trips, relays and fuses to be set to the required values and settings. Prior to final inspection, arrange for the switchgear manufacturer, or the (coordination agency) to visit the site to check all settings to ensure they are in accordance with coordination study values.
- .12 Arc Flash Analysis
- .1 Perform an arc flash analysis study in conjunction with the previous specified short circuit and protective device coordination study. This arc flash analysis study to be performed in accordance with IEEE Std 1584a.
 - .2 The study shall be calculated by means of a digital computer, using the latest version of applicable software. Pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the student.
 - .3 Determine the following for each bus analyzed:
 - .1 Flash Hazard Protection Boundary
 - .2 Incident Energy Level
 - .3 Required Personal Protective Equipment Category
 - .4 Type of Fire Rated Clothing
 - .5 Limited Approach Boundary
 - .6 Restricted Approach Boundary
 - .7 Prohibited Approach Boundary
- .13 Power Quality Analysis
- .1 Div. 26 shall allow for a power quality study three months after the building is fully occupied and operational.

Part 2 Products

2.1 WARNING LABELS

- .1 Produce an Arc Flash Warning label for each piece of electrical equipment with a specific equipment ID. Also include the system operating voltage and date of issue. Labels shall be printed in colour on adhesive backed nylon labels.

Part 3 Execution

3.1 ANALYSIS OF SHORT CIRCUIT CALCULATIONS

- .1 Analyze the short circuit calculations, protective device coordination, and arc flash calculations and highlight an equipment that is determined to be underrated as specified or cause abnormally high incident energy levels. Propose approaches to effectively protect the underrated equipment and to reduce the energy levels. Provide minor modifications to conform with the study (Examples of minor modifications are trip sizes within the same frame, the time curve characteristics of induction relays, CT ranges, ect.). After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination. Proposed major corrective modifications will be taken under advisement by the Engineer, and the Contractor will be given further instructions.

3.2 ARC FLASH ANALYSIS STUDY

- .1 Present the data determined by the Arc Flash Analysis Study in a tabular format summary sheet. Include the following for each bus analyzed:
 - .1 Flash Bus Name
 - .2 Protective Device Name
 - .3 Bus Operating Voltage
 - .4 Bus Bolted Fault Current
 - .5 Protective Device Bolted Fault Current
 - .6 Protective Device Arcing Fault Current
 - .7 Trip/Delay Time (Sec)
 - .8 Breaker Opening Time (Sec)
 - .9 Ground
 - .10 Equipment Type
 - .11 Gap (mm)
 - .12 Arc Flash Boundary (in)
 - .13 Working Distance (in)
 - .14 Incident Energy (cal/cm²)
 - .15 Required Protective FR Clothing Category

3.3 FINAL WRITTEN REPORT

- .1 The results of the power system study shall be summarized in a final written report. The report shall include the following sections:
 - .1 Introduction, executive summary, recommendations, and assumptions
 - .2 Electrical One-Line(s) with previously identified specific data values
 - .3 Tabulations of equipment ratings versus calculated short circuit values and X/R ratios, arc flash values
 - .4 Protective device time versus coordination curves, tabulations of relay and circuit breaker trip settings and fuse selection with commentary
 - .5 Engineering analysis, commentary, and recommendations
 - .6 The report is to be stamped by a professional engineer.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 REFERENCES

- .1 Use transformers of one manufacturer throughout the project.
- .2 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No.47, Air Cooled Transformers (Dry Type).
 - .2 CSA C9, Dry Type Transformers.

1.4 PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 26 05 00.

Part 2 Products

2.1 HARMONIC MITIGATION TRANSFORMERS

- .1 Transformers to be tested certified to meet high efficiency CSA standard (802.2-18, NEMA TP-11 Energy Star requirements for dry type transformers certified and bear the C802.2-18 & ENERGY STAR Logos.
- .2 Harmonic Treatment: 3rd, 9th, 15th ... on the secondary and 5th, 7th, 17th, 19th, etc. with 30° phase shift on the primary common bus.
- .3 Copper Windings.
- .4 K-20 load profile, crest factor of 5.
- .5 Secondary Windings: Wound to mitigate zero sequence current flux. These zero-sequence currents shall not be coupled into the primary winding of the transformer.
- .6 Phase Shift: Windings configured to provide primary-to-secondary phase shift of -30° or 0°
- .7 Zero Sequence Data: Less than 0.95% ZS impedance, less than 0.3% ZS reactance.
- .8 Nameplate Impedance: 2.5 – 4.0% (up to 75 KVA), 5.0% max (112.5-300 KVA).
- .9 Insulation Class 220, 130°C Operating Temp Rise.
- .10 Neutral Rating: 200% of rated secondary phase current

2.2 VIBRATION AND SEISMIC CONTROL

- .1 Vibration and Seismic control shall meet the requirements of current National Building Code and Supplements, and the seismic consultant.
- .2 Vibration and Seismic hardware to control static deflection.
- .3 Transformer equipment to be vibration isolated from the building structure by means of approved Neoprene isolators. Isolation system to have a mutual frequency no higher than one-third of the fundamental frequency.

- .4 Provide inspection services by a qualified isolator manufacturers representative during and after installation. Provide concise written reports accepting the installation and stating any deficiencies. Correct any deficiencies noted. Include all costs associated with the above in the base tender. Use Electrical Form EF132 bound with this specification in Appendix A.
- .5 Refer to Section 26 05 00 for Vibration Isolation of Electrical Equipment

2.3 STANDARD OF ACCEPTANCE

- .1 Delta
- .2 Hammond
- .3 Schneider
- .4 Eaton
- .5 Marcus
- .6 Rex Power
- .7 Pre-approved equal

Part 3 Execution

3.1 MOUNTING

- .1 Mount dry type transformers on floor unless otherwise noted on drawings.
- .2 Provide 100 mm [4"] concrete house-keeping base pad unless otherwise detailed.
- .3 Ensure adequate clearance around transformer for ventilation.
- .4 Install transformers in level upright position.
- .5 Remove shipping supports only after transformer is installed and just before putting into service.
- .6 Loosen isolation pad bolts until no compression is visible.

3.2 CONNECTIONS

- .1 Make primary and secondary connections in accordance with the manufactures diagrams.
- .2 Check all factory connections for correct tightness before energization.
- .3 Torque the building system wiring transformer connections using a torque wrench set to the manufacturers recommended settings. Note the torque setting on the equipment identification label for future maintenance reference.
- .4 All external wiring connections to transformer casing shall be enclosed in flexible conduit. Typically minimum 900mm[36"] flex to minimize vibration transmission to building structure.
- .5 Conduit to only enter transformers within the bottom third of the transformer casing. (to minimize heat transfer to conduit).
- .6 Energize transformers immediately after installation is completed, where practicable.

3.3 EQUIPMENT IDENTIFICATION

- .1 Size 7 label in accordance with Section 26 05 00.
- .2 Include the transformer identification (as indicted on the project drawings), primary power source equipment designation, equipment served and torque setting of connections. Eg Transformer T1, served from CDPH-1, serving CDPL-1, Cable Connection Torque x Nm.

3.4 GROUNDING

- .1 Provide a ground conductor with all feeder runs to dry type transformer installations. The ground shall be either green insulated or identified and connected as a ground to the ground pad in the transformer enclosure and thence to the secondary neutral of the transformer. From the transformer ground pad make cable connection to non-current carrying ground of the distribution centre or panel supplied from transformer.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 REFERENCES

- .1 The latest edition of the following codes and standards shall apply:
 - .1 CAN/CSA C22.2 No. 31 - Switchgear Assemblies

1.4 SCOPE OF WORK

- .1 Provide a complete system of secondary sub distribution.
- .2 Note that the electrical rooms have limited space. Refer to drawings for restrictions. Equipment has to be built to fit available space.

1.5 SHOP DRAWINGS PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 26 05 00.
- .2 Shop drawings units of measurement shall be SI Units
- .3 Shop drawings shall be submitted to the Consultant for review prior to the manufacture of the equipment.
- .4 Shop drawings shall include:
 - .1 Bill of Materials (Major Components including any protective relays).
 - .2 Recommended spare parts including prices, quantities and manufacturer's part numbers.
 - .3 Single line and schematic wiring diagrams showing the any protective relaying, metering and control wiring.
 - .4 Cable terminal sizes
 - .5 Product data sheets
 - .6 Model and make of protective relay
 - .7 Sensor rating of each breaker
 - .8 Breaker and/or fusible-switch layout, type, quantity and ampacity.
 - .9 AIC rating of all components.
 - .10 Complete and integrated fuse/breaker co-ordination curves.
 - .11 Switchboard construction and anchoring method.
 - .12 Dimensioned cable entry and exit locations.
 - .13 Dimensioned position and size of bus.
 - .14 Dimensioned layout of internal and front panel mounted components.
 - .15 Overall length, height and depth of enclosures.

- .5 The following information shall be submitted for record purposes:
 - .1 Final as-built drawings and information for items listed in the above paragraphs.
 - .2 Wiring diagrams
 - .3 Certified production test reports
 - .4 Installation information
 - .5 Seismic certification.
 - .6 Coordination Curve / Time Current Curve provided as to actual settings of Circuit breakers.
 - .7 The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process

1.6 SWITCHGEAR FUSE/CIRCUIT BREAKER CO-ORDINATION

- .1 Switchgear shall be coordinated to ensure that the device nearest to the overload or fault opens first under all overload and fault condition. Verify the ratings and settings of all devices.

1.7 PLANT ASSEMBLY

- .1 Install circuit breakers and/or fusible-switches in switchboards before shipment from plant.
- .2 Assemble and wire complete secondary switchgear and metering components.
- .3 After completion of tests, prepare switchgear for shipment to site, complete with hardware for re-assembly and re-connecting.
- .4 In addition to CSA requirements, manufacturer's nameplate must show fault current rating of the switchboard assembly.

1.8 FINISH

- .1 Apply finishes in accordance with Section 26 05 00; Cubicle exteriors - grey.

1.9 HOUSE KEEPING PADS

- .1 Provide 100 mm [4"] high (nominal) concrete house keeping pads under all floor mounted equipment unless otherwise indicated.

1.10 MAINTENANCE DATA

- .1 Provide data for incorporation into maintenance manual specified in Section 26 05 00.

Part 2 Products

2.1 ENCLOSURES

- .1 Switchgear to be metal enclosed, floor mounted, dead front, indoor enclosure, "Sprinklerproof" design. Bulkhead style including sides, top, door(s), bottom enclosing plate, sills, horizontal and vertical barriers, lintels, supports, reinforcing members; formed, welded and braced into rigid self-supporting structure. Constructed from rolled flat steel sheets.
- .2 Remove burrs and sharp edges from steel work.
- .3 Use non-corrosive bolts and hardware.
- .4 Access from front only.

- .5 Each tub trim cover to be hinged and self supporting and to swing out to expose breaker cable terminations and wireways. Hinged trim shall be secured with cover screws on opening side by machine screws. Cover to be dished, turned edge or similar design to provide rigidity. Hinged breaker cover shall be recessed into the hinged overall tub cover. Breaker cover shall have latch type closures. Tub cover shall be secured to tub. Submit details on shop drawings prior to manufacturing.
- .6 Each breaker in the CDP switchboards and panels to be fed with its own set of connector and hardware to allow mounting of similar breakers opposite to one another in double row configuration. Provide all necessary connectors and mounting hardware in every space to facilitate the installation of future breakers.
- .7 Circuit breakers trip size to be visible without removal of the trim. Magnetic adjustment shall be accessible without removal of the trim.
- .8 Cubicle units to have adequate bracing, sufficient volume and ventilating openings to prevent distortion of unit during normal operation and during fuse and circuit breaker operation under short circuit conditions, or when attempting switch closure onto fault.
- .9 Provide "sprinkler-proof" design where equipment is located in areas where sprinkler fire protection is installed. All ventilation slots to be provided with angled louvres to prevent entrance of water from the sprinkler fire protection system.
- .10 Bus bars to be copper.
- .11 Provide main bus ampacity and rating as indicated on the drawings.
- .12 Equipment shall be internally braced to withstand seismic forces.
- .13 Provide integrally mounted TVSS equipment where indicated

2.2 **CIRCUIT BREAKERS – MOULDED CASE**

- .1 Moulded case circuit breakers to CSA C22.2 No. 5.
- .2 Bolt-on moulded case thermal magnetic circuit breaker, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Thermal and instantaneous magnetic trip.
- .4 Common-trip breakers with single handle for multiple applications with trip free action and "trip" position separate from "on" and "off" positions.
- .5 Trip rating clearly visible and legible with finished panel trim installed.
- .6 Main breaker shall be:
 - .1 Moulded case or air circuit breaker, 3 pole, rated 600 VAC, with solid state overcurrent sensor and ground fault protection function.
 - .2 Minimum 25,000 amps symmetric interrupting capacity or as indicated on drawings.
- .7 Sub circuit breakers shall be:
 - .1 Moulded case 3 pole with solid state overcurrent sensors.
 - .2 Minimum 18,000 AIC symmetrical for 240 volt or as indicated on drawings.
 - .3 Minimum 25,000 AIC symmetrical for 600 volt or as indicated on drawings.

2.3 **SOLID STATE TRIP AND PROTECTIVE RELAY ASSEMBLIES**

- .1 Voltage: and poles as indicated in schedules.
- .2 Interrupting Capacity: 25,000 A symmetrical.

- .3 Construction (breaker): bolt-in or draw out (stabs) as indicated.
- .4 Mounting: vertical.
- .5 Normal operation: 40°C ambient.
- .6 Breaker frame: moulded case breaker or air break type design as indicated.
- .7 Breakers shall be equipped with electronic solid-state overcurrent relays.
- .8 The solid-state trip devices shall include the following adjustments:
 - .1 Long delay pickup.
 - .2 Long delay time.
 - .3 Short delay pickup.
 - .4 Short delay time.
 - .5 Instantaneous trip.
 - .6 Ground fault pickup.
 - .7 Ground fault delay time
- .9 Each solid state unit shall include a LED or LCD display indicating the following:
 - .1 Cause of trip
 - .2 Peak level of fault current
 - .3 Phase current.
 - .4 Communications capability.
 - .5 Energy use KWH, kVA, kW, KVARs.
 - .6 Zone selective instantaneous protection
- .10 The solid-state relay shall trip the circuit breaker independent of trip/close control circuits.
- .11 Current monitors:
 - .1 Type: transformer.
 - .2 Mounting: bus.
 - .3 Number required: 4 (3 wire and N system).
- .12 Sensor Unit:
 - .1 Type: solid state electronic sensor powered from current monitor source.
 - .2 Calibration: visible identified trip adjustment-calibration from front of breaker.
 - .3 Mounting: on or within breaker frame.
 - .4 Trip Actuation: powered by circuitry within the monitor sensor device.
 - .5 Trip Actuation: visual On/Off.
- .13 The current coils of all relays and meters shall be capable of withstanding momentary current transformer secondary currents of approximately 20 times the coil rating without incurring any damage.
- .14 Bolt-on moulded case circuit breaker, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .15 Common-trip breakers with single handle for multiple applications with trip free action and "trip" position separate from "on" and "off" positions.

- .16 Breakers shall be:
 - .1 Moulded case or air circuit breaker, 3 pole, rated 600 VAC, with solid state overcurrent sensor and ground fault protection function as indicated.
 - .2 Minimum 18,000 AIC symmetrical for 240 volt or as indicated on drawings.
 - .3 Minimum 25,000 AIC symmetrical for 600 volt or as indicated on drawings.

2.4 GROUNDING

- .1 Copper ground bus not smaller than 50 x 6 mm [2"x ¼"] extending full width of cubicle and situated at bottom. Ground bus to be accessible without reaching over the main live bus.
- .2 Lugs at each end for size 4/0 AWG grounding cable.
- .3 Bond non-current carrying metal parts, including switchgear framework, enclosure and bases to ground bus.

2.5 OWNERS OR MONITORING METERING

- .1 Phase metering current transformers shall be located in the circuit breaker compartment on the line and/or load bus as shown on the drawings. The CT's shall be mechanically and thermally rated to withstand any fault condition.
- .2 Secondary windings of phase metering current transformers shall have a nominal rating of 5 A and metering accuracy ratings of 0.6% or better.
- .3 Potential transformers if required shall be located in the low voltage control compartments and shall include both primary and secondary HRC fuses. The primary fuses shall be installed in "pull out dead front" fuse holders.
- .4 Potential transformers shall have 120 V secondary's and metering accuracy ratings shall be 0.6%
- .5 Microprocessor digital metering equipment to be equal to:
 - .1 Cutler Hammer IQ Analyzer 6600.

2.6 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Nameplates:
 - .1 White plate, black letters, size 7.
 - .2 Identify voltage, phases, and ampacity.
 - .3 Distribution section - labeled as indicated.

2.7 STANDARD OF ACCEPTANCE

- .1 Eaton
- .2 Schneider

Part 3 Execution

3.1 INSTALLATION

- .1 Locate switchgear assembly as indicated. Any variations to be pre-approved by the Consultant.
- .2 Install the switchgear with due care and attention. Ensure that the factory finish is not damaged, dented, scratched or warped. Ensure that the switchgear is not dropped or subjected to excessive vibration. The Contractor shall repair and make good any damage or perceived damage to the switchgear to the satisfaction of the Consultant.

- There shall be no extra costs to the Owner for restoring or repairing the switchgear to the satisfaction of the Consultant.
- .3 The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.
 - .4 Check factory made connections for mechanical security and electrical continuity. Tighten electrical connectors and terminals, including screws and bolts in accordance with equipment manufacturer's published torque tightening values.
 - .5 Install switchgear on 100 mm [4"] concrete housekeeping pad unless otherwise detailed.
 - .6 Provide all necessary hardware to secure the assembly in place. Secure assemblies to foundation or floor channels. The switchgear shall be seismically restrained.
 - .7 Connect load side of breakers in distribution section to distribution feeders as indicated.
 - .8 Measuring and record insulation megohm meter readings - phase-to-phase, phase-to-ground, and neutral-to-ground (where applicable).
 - .9 Install switchgear accessories cabinet in electrical rooms.
 - .10 Provide conduit and signal communications wire as specified by manufacturer or as indicated in these specifications. Make connection to digital meters and/or networked metering communication system.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 00.
- .2 Shop drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- .3 Shop drawings to include matching tub and trim details for factory installed low voltage relay cabinets where specified.

1.4 PLANT ASSEMBLY

- .1 Install circuit breakers in panelboards before shipment from plant.
- .2 Install and prewire low voltage relays assemblies where indicated.
- .3 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .4 All panelboards to be of a common manufacturer.

1.5 FINISH

- .1 Apply finishes in accordance with Section 26 05 00.
- .2 Panel finish in electrical and equipment rooms and closets to be standard ASA Grey baked enamel for normal power service and Blue for emergency power service. Confirm with Consultant prior to shop finishing panels.
- .3 Panels in finished and/or public areas to be either as clause .2 above or prepared to accept painting to closely match surroundings as directed by the Architect. In the later instance, the final paint coat to be done by Division 09 but coordinated by the Electrical Division in particular for protection and masking of locks and sensitive parts. Confirm with Consultant prior to paint finishing panels.

Part 2 Products

2.1 PANELBOARDS, DOORS AND TRIMS

- .1 Panelboards: to CSA C22.2 No. 29 and product of one manufacturer.
- .2 Bus and breakers rated for 10 KA symmetrical, minimum, interrupting capacity or as indicated.
- .3 Copper bus with full size neutral.
- .4 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number.
- .5 Mains, number of circuits and number and size of branch circuit breakers as indicated.
- .6 Provide all necessary connectors and mounting hardware in every space to facilitate installation of future breakers. Provide blank fillers for all spaces.

- .7 Concealed hinges and concealed trim mounting screws, hinged locking door with flush catch.
- .8 Panelboards to have flush doors (gasketed where required).
- .9 Provide two keys for each panelboard and key similar voltage panelboards alike.
- .10 Panel tubs to be typically 600mm [20"] wide.
- .11 Provide "sprinkler-proof" design in areas where sprinkler fire protection is installed. In any event, all surface mounted enclosures to be complete with sprinkler drip cover.

2.2 BREAKERS

- .1 All breakers to be bolt on type, moulded case, non adjustable and non interchangeable trip, single, two and three pole, 120/208V, 277/480V or 347/600V and with trip free position separate from "On" or "Off" positions.
- .2 Two and three pole breakers to have common simultaneous trip and able to be located in any circuit position within the panelboard. Minimum interrupting rating of breakers to be as follows:
 - .1 347/600V panelboards - 14,000 Amps at 347 volts.
 - .2 120/208V panelboards - 10,000 Amps at 250 volts.
 - .3 277/480V panelboards - 14,000 Amps at 480 volts.
- .3 Main breaker to be separately mounted at top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Provide circuit breakers with indicated trip ratings as shown in the panelboard schedules.
- .5 Provide at least 10% spare 15 Amp single pole breakers whether indicated or not.
- .6 Provide GFCI type breakers as indicated.
- .7 Provide Lock-on devices as indicated and in any event for Fire Alarm circuits, Security equipment circuits, EXIT sign circuits and Emergency Battery equipment circuits. Provide 10% lock-on devices for each panelboard. Turn over unused lock-on devices to the Owner.

2.3 PANELBOARD IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Nameplate for each panelboard size 5 (2 line) engraved as indicated and include panel designation and voltage/phase.
- .3 Complete circuit directory with typewritten card(s) located in slide-in plastic pocket(s) fixed to the back of the related door. Directory card to indicate the panel designation, mains size, voltage/phase and the location and load controlled of each circuit. Include a "letter sized" paper copy of each directory in the project maintenance manual.
- .4 Provide a plasticized typewritten information card fixed to the back of the each panel door. Information card to indicate the panel designation and location, feeder type and size and locations of any controlling contactors and feeder pullboxes. Include a "letter sized" paper copy of each information card in the project maintenance manual.

2.4 STANDARD OF ACCEPTANCE

- .1 Eaton
- .2 Schneider

Part 3 Execution

3.1 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb true and square, to adjoining surfaces.
- .2 Panelboards located in service rooms, mechanical rooms, and electrical rooms to be mounted on unistrut supports.
- .3 Mount panelboards to height given in Section 26 05 00 or as indicated.
- .4 Connect loads to circuits as indicated.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 Install 4 x 27mm [1"] empty conduits (or equivalent) from each flush mounted panelboard single tub to ceiling space above and 2 x 27mm [1"] empty conduits (or equivalent) from each flush mounted panelboard single tub down to ceiling or space below where space exists. Refer also to Section 26 05 34 "Conduits".

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Section 26 24 16 Panelboards
- .3 Section 26 23 00 Low Voltage Switchgear

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 SOURCE OF SUPPLY

- .1 All units shall be of one manufacturer.

1.4 STANDARDS

- .1 SPD units and all components shall be designed, manufactured, tested, and installed in compliance with the latest applicable standards:
 - .1 ANSI/IEEE C62.41.1
 - .2 ANSI/IEEE C62.41.2
 - .3 ANSI/IEEE C62.45
 - .4 UL 1449, 2nd edition
 - .5 UL 1283
 - .6 CSA 22.2 5th edition or later
 - .7 NFPA 780
 - .8 UL96A
 - .9 ANSI/UL 1449 4th edition or later
 - .10 IEEE C62.48-2005
 - .11 IEEE C62.62-2010MIL-STD-220A

1.5 SUBMITTALS

- .1 In addition to items specified in Section 26 05 00 submit the following information for review at time of shop drawings submittal:
 - .1 ULC1449, 2nd edition listing card for each product submitted.
 - .2 Clamping voltage measured and presented in accordance with NEMA LS1-1992 showing clamping voltages for the C62.41 category B3 ring wave, category B3/C1 combination wave, and category C3 combination wave. Clamping voltages shall be measured from the zero reference to the peak of the limited surge and the test surge shall be injected at the 90 degree phase angle (i.e. the positive peak of the sine wave as required by NEMA LS1-1992. All testing shall be independently certified by a nationally accredited test facility.
 - .3 High frequency noise attenuation presented in accordance with NEMA LS1-1992 over a spectrum of 100kHz to 10MHz. Attenuation values shall be in a range of 30db to 60db provided at discrete frequencies of 100kHz, 1MHz and 10MHz.

Attenuation values provided at a single frequency or no particular frequency will not be acceptable.

- .4 Electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- .5 Where applicable, the following additional information shall be submitted to the engineer:
 - .1 Descriptive bulletins
 - .2 Product sheets

1.6 ENVIRONMENTAL REQUIREMENTS

- .1 Operating range: -40°C to +40°C.
- .2 Operation shall be reliable in an environment of 5% to 95% non-condensing relative humidity.
- .3 The unit shall be capable of operation in altitudes of up to 4000m above sea level.
- .4 This unit shall not generate any audible noise.
- .5 No appreciable magnetic fields shall be generated. Unit shall be capable of use directly in computer rooms in any location without danger to data storage systems or devices.

Part 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- .1 Eaton
- .2 Schneider
- .3 Approved alternate

2.2 ELECTRICAL REQUIREMENTS

- .1 System Voltage: 347/600V, 277/480V and 120/208V, 3 phase, 4 wire grounded wye as indicated.
- .2 Maximum Continuous Operating Voltage of all Suppression Components:
 - .1 125% of facility's nominal operating voltage for 120 V systems.
 - .2 115% of facility's nominal operating voltage for 220, 240, 277,480, 347, 600 V systems.
- .3 Operating frequency: from 50 to 62 Hz.
- .4 Protection Mode: The unit shall provide protection on wye configured systems for:
 - .1 line to neutral transients.
 - .2 line to ground transients.
 - .3 neutral to ground transients.
- .5 Single Pulse Surge Current Capacity: Based on ANSI/IEEE C62.41 standard 8 × 20µs current waveform, the maximum repetitive surge current capacity of the unit shall be no less than:

Mode of Operation	Main	
	Panelboards	Switchboard
Line to Neutral	80,000A / Phase	200,000A/Phase
Line to Ground	80,000A / Phase	200,000A/Phase
Neutral to Ground	80,000A / Phase	200,000A/Phase

- .6 UL 1449, 2nd Edition SVR - The maximum UL 1449, 2nd Edition SVR for the device must not exceed the following:

Mode:	208Y/120	480Y/277	600Y/347
L-N, L-G, N-G	400V	800V	1000V
L-L	700V	1500V	1800V

ANSI/IEEE Cat. C3 clamping voltage measured per NEMA LS1-1992 based on IEEE C62.41 and C62.45 recommended procedures for Category C3 combination wave (20kV, 10kA) shall be less than:

Mode:	208Y/120	480Y/277	600Y/347
L-N	500V	900V	1300V

- .7 ANSI/IEEE Cat. B3 clamping voltage measured per NEMA LS1-1992 based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Cat. B3 ringwave (6 kV, 500 A) shall be less than:

Mode:	208Y/120	480Y/277	600Y/347
L-N	150V	200V	300V

- .8 Life Expectancy: The unit shall be capable of protecting against and surviving at least 8000 ANSI/IEEE C62.41-1991 Category C3 (20 kV open circuit, 10 kA short circuit) surges without failing or degrading the measured limiting voltage (MLV) by more than 10%.

2.3 SPARE PARTS

- .1 A list of customer replaceable spare parts shall be included with the installation, operating and maintenance instructions.

2.4 WARRANTY

- .1 The manufacturer shall provide a written warranty of no less than ten (10) years against failure. Warranty to be provided directly to the owner and to be valid starting at facility takeover date.

2.5 PERFORMANCE

- .1 Unit shall include an engineered solid-state high performance hybrid suppression system utilizing an array of selenium cells and/or non-linear voltage dependent metal oxide varistors and capacitive filter components. The suppression system shall not utilize gas tubes, spark gaps, or silicon avalanche diodes. Clamping voltage shall be measured as per NEMA LS1-1992 guidelines.

2.6 FILTERING

- .1 The unit shall contain a high performance EM/RFI noise rejection filter. The filter shall reduce fast rise-time, high frequency, error producing transients and electrical line noise to harmless levels. The filter shall provide minimum insertion loss utilizing MIL-STD-E220A 50 ohm methodology as follows:

Attenuation Frequency	100 kHz	1 MHz	10 MHz
Attenuation (dB)	55	56	54

2.7 STATUS INDICATION

- .1 The unit shall include LED indicators, which provide indication of suppression component failure for all modes including neutral to ground. Provide one (1) set of dry contacts for remote monitoring of protection failure by BMS (Building Management System). Contacts to activate upon failure of any one phase or degradation of total surge capacity to less than 75%.

- .2 All units shall be testable in the field in order to verify the exact level of protection remaining using either built-in features or a hand-held tester.

2.8 DIAGNOSTIC MONITORING

- .1 All units shall provide the following levels of diagnostic monitoring:
 - .1 Continuous monitoring of internal fuses and be equipped with the ability to alarm.
 - .2 Internal sensor system for monitoring MOVs including neutral to ground.
 - .3 Monitoring and adequate protection for temporary over voltage (TOV) monitoring.

2.9 PROTECTION

- .1 Integral SPD fusing shall be provided that provides proper fault protection per CEC 2002 in the event of MOV failure but does not operate during normal operation where the unit is required to conduct an 8 x 20 μ s surge current equal to its per mode rating. Vendor shall provide independent single pulse test data verifying that the unit can withstand its advertised per mode surge rating per NEMA LS1-1992 and IEEE/ANSI C62.45.
 - .1 Fusing shall be rated to 200k AIC
 - .2 Thermal Protection: MOV's shall be equipped with thermal protection technology which allows disconnection of the suppression component at the overheated stage common during temporary over voltage condition. For small fault currents between 100mA to 30A, or if the occurrence is over a longer period of time, the thermal protection will disconnect first. Manufacturers that utilize fuse traces only shall not be approved.
 - .3 All overcurrent protection components shall be tested in compliance with UL 1449-Limited Current Test and AIC rating test.

2.10 ENCLOSURE

- .1 Integral to panelboards and/or Distribution Centres. Refer to single line diagram.

Part 3 Execution

3.1 INSTALLATION

- .1 Install units integral to designated panelboards as shown on single line diagram. The installation of SPD shall be factory installed integral to the distribution equipment. The contractor shall install all distribution equipment per the manufacturer's recommendations, applicable electrical codes and the contract drawings.
- .2 Where units are mounted integral with panelboards, status LEDs shall be visible without removing covers.
- .3 Where units are mounted remote from the panelboard or distribution centre, ensure that the leads from breaker terminals to SPD unit do NOT exceed 150 mm [6"] and the use low impedance wiring methods shall be used. SPD devices shall also be closely coupled to the distribution device when used in the remote form.
- .4 All enclosed SPD equipment shall have NEMA 1 stainless steel enclosure, constructed of ANSI 61 painted steel, intended for indoor use, and suitable for locations as indicated on the single line diagram.

3.2 FACTORY TESTING

- .1 Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA, IEEE, and UL standards.

3.3 INSTALLATION

- .1 The contractor shall install all equipment per manufacturer recommendations, applicable electrical codes, and the contract drawings.

3.4 WARRANTY

- .1 The manufacturer shall provide a 10 (ten) year warranty (15 year warranty with optional registration) that covers replacement of the complete unit, including damage from lightning, from the date of shipment against any surge device part failure when installed in compliance with manufacturer's written instructions and any applicable national or electrical code.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Section 26 24 21 "HVAC & Plumbing Controls.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 26 05 00.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.4 OPERATION AND MAINTENANCE DATA

- .1 Provide data for incorporation into maintenance manual specified in Division 01 and Section 26 05 00.
- .2 Include operation and maintenance data for each type and style of starter.

1.5 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 26 05 00.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 2 contacts, stationary.
 - .2 2 contacts, movable.
 - .3 1 contact, auxiliary.
 - .4 1 control transformer.
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 4 indicating lamps.

1.6 HOUSE KEEPING PADS

- .1 Provide 100mm [4"] high (nominal) concrete house keeping pads under all floor mounted switchboards.

Part 2

Products

2.1

MATERIALS

- .1 Starters: to CSA C22.2 No.14.
- .2 Half size starters not acceptable.

2.2

MANUAL MOTOR STARTERS

- .1 Single phase manual motor starters of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 One overload heater, manual reset, trip indicating handle.
 - .3 Flush mounted in finished areas.
 - .4 Pilot light.
- .2 Accessories:
 - .1 Toggle switch labelled as indicated.
 - .2 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3

FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Three pole adjustable overload relay(s) with single phase protection feature
 - .3 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .4 Wiring and schematic diagram inside starter enclosure in visible location.
 - .5 Provide a fixed 10 point terminal strip for all controls.
 - .6 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
 - .7 Control transformers to be line voltage to 120 V of sufficient VA to handle operating coil and associated auxiliary controls. Provide primary and secondary HRC fusing.
 - .8 Provide fused circuit and terminal blocks.
 - .9 Provide the following accessories:
 - .1 Hand-off-auto selector switches, start/stop/reset buttons or on/off control as indicated.
 - .2 Loads served labelled as indicated.
 - .3 Indicating lights: standard type and colour as indicated.
 - .4 2-N/O and 2-N/C spare auxiliary contacts in addition to the holding contacts unless otherwise indicated.
 - .5 Support facilities for load sensing ring type CT on Phase C of motor circuit
- .2 Two sets of auxiliary contacts - normally Open in addition to standard auxiliary holding contacts supplied with each contactor making a total of three auxiliary contacts. One set of auxiliary contacts to be convertible to normally closed.

- .3 CEMA 1 enclosure unless otherwise indicated.

2.4 COMBINATION STARTERS

- .1 In addition to "Full Voltage Magnetic Starters" above, provide 3 pole magnetic trip moulded case breaker (MCP) and operating handle with lock-off facility.
- .2 Enclosure "Opening" to be restricted by use of a defeater screw unless switch is in "Off" Position.

2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 5 engraved as indicated.

2.6 STANDARDS OF ACCEPTANCE

- .1 Eaton
- .2 Schneider

Part 3 Execution

3.1 INSTALLATION

- .1 Install starters.
- .2 Connect power and control as indicated.
- .3 Provide interlocking between starters where required.
- .4 Provide relays for fire alarm shutdown. Relays to be approved by Fire Alarm manufacturer and to be powered by the fire alarm panel or approved 24VDC source.
- .5 In finished areas, provide flush mounted remote controls and manual motor protection starters complete with stainless steel coverplates and pilot lights unless otherwise indicated. Provide key operated motor protection starters where indicated or in normally accessible areas where unauthorized operation could be a functionality issue.
- .6 Select overload settings to suit full load current of motors installed that may differ from the design loads. Confirm with other Divisions.
- .7 Ensure correct control fuses and overload devices elements installed.
- .8 Provide disconnects at all equipment.
- .9 Monitored through BMS.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 and manufacturer's instructions.
- .2 Operate controls, switches, contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SCOPE OF WORK

- .1 In general the HVAC and the Plumbing/Fire Protection motors and drives will be respectively provided under the Mechanical Division and Plumbing/Fire Protection Divisions. Refer to the related division of the specifications and drawings for exact locations and requirements.
- .2 Provide the following components:
 - .1 All disconnect switches required.
 - .2 All starters, contactors, control transformers, except where supplied by the Mechanical or Plumbing/Fire Protection Divisions as noted in the equipment schedule.
- .3 Thermostats, solenoid valves, pressure switches, aquastats, flow switches, timeclocks are generally provided by the Mechanical or Plumbing Divisions except as noted in the equipment schedule(s).
- .4 Refer to equipment schedule(s) for details of motor controls and devices.
- .5 Provide all power wiring from power distribution centre, through starter and control equipment to the motors.
- .6 Conduit, wire and connections for all HVAC low voltage control wiring shall be the responsibility of Mechanical Division unless otherwise specified.
- .7 Provide, connect and verify all Fire Alarm control wiring and devices.

1.3 CONTROLS - GENERAL

- .1 Mechanical and Plumbing Divisions differ both in regard to the particulars of drives, motors, etc. specified. The Mechanical Division typically includes a major section on controls whereas the Plumbing Division typically includes more package equipment requiring power service connection only. Because of these variations the demarcation point between the work of the Electrical Division and the Mechanical and Plumbing Divisions typically differ.
- .2 Generally for drives, equipment, etc. detailed in the Mechanical Division, the work of the Electrical Division finishes with the supply of a standard terminal block array for each starter. All further wiring, relays, timers, etc., together with control consoles, are provided under the Mechanical Division.
- .3 Generally for the package equipment, drives and special controls detailed in the Plumbing Division, the work of the Electrical Division typically includes the provision of all wiring, devices, etc to complete each system and left ready for commissioning, set up, etc. by the Plumbing Division.

1.4 ELECTRICAL DIVISION RESPONSIBILITIES FOR MECHANICAL DIVISIONS

- .1 Provide a ten point terminal block for each starter or contactor.
- .2 Provide interwiring between starters or contacts and terminal blocks. Starter to be entirely factory-wired.
- .3 Terminals to be as follows:
 - .1 120 V line from control transformer.

- .2 Terminals for remote 3 wire stop/start.
 - .3 HOA or other control.
 - .4 120V neutral.
 - .5 Normally open dry contact.
 - .6 Common.
 - .7 Normally closed dry contact.
 - .8 Normally open dry contact.
 - .9 Common.
 - .10 Normally closed dry contact.
- .4 Except where otherwise indicated, the work of the Electrical Division shall not extend beyond the control terminal blocks. The Mechanical Division shall provide all conduit, wire, wiring connections and components such as relays, timers, etc. as required to provide the interlocking functions and controls as outlined in the specifications. If the standard terminals supplied by the Electrical Division require supplementation in any way, e.g. by supplying additional N.O. or N.C. contacts, these facilities are included in the Mechanical Division Mech Div scope.
- .5 Mechanical Division shall provide the mechanical control consoles complete with pilot controls, indicating lights, etc., as outlined in the specifications.
- .6 When an item provided under the Mechanical Division is factory supplied with a starter or contactor and it is necessary to alter or add to the control wiring in order to achieve the method of operation specified in the Mechanical Division, this work shall be included in Mechanical Division.
- .7 When control items such as thermostats, float controllers, etc., are connected to power wiring in series with the item being powered (e.g. unit heater motor, fractional HP fans, etc.) the supply and installation of the controller devices are included in Mechanical Division. Power wiring to and from the controllers is included in the Electrical Division. Install line voltage thermostats for single phase motors provided by the Mechanical Division where specifically indicated on the drawings and/or the "Equipment Schedule" of this specification.
- .8 When the electrical characteristics of a controlled item exceed the capacity of a specified controller, provision of a contactor and the required wiring shall be included in the Mechanical Division.

1.5 ELECTRICAL DIVISION RESPONSIBILITIES FOR PLUMBING DIVISIONS

- .1 When a drive, motor, etc. provided under the Plumbing Divisions is factory supplied with a starter, contactor, alternator, pressure switch, etc., the wiring and installation of these items and controls shall be included in the Electrical Division.
- .2 The ten point terminal blocks similar to those specified under the Mechanical Division controls are not mandatory for the Plumbing Division equipment.
- .3 The Electrical Division shall provide stop/start or HOA controls as specified for each item except where these stations are factory supplied with equipment.
- .4 The Electrical Division shall leave each system fully functional and requiring only minor final adjustments (such as pressure or vacuum settings) by the Plumbing Divisions.

Part 2 Products

2.1 MATERIALS

- .1 Refer to appropriate section of the Electrical Division(s).

2.2 CONTROL RELAYS

- .1 Control relays to be rated minimum 10 A, 300V, with contacts as required and 120 V control coil unless otherwise noted. Relays to be typically mounted in CEMA1 enclosures located in control terminal cabinets and/or MCC.
- .2 Provide required fire alarm relays and auxiliary contacts in motor control centres or at the related equipment cabinets to provide activation and deactivation of mechanical fan units as specified in the Mechanical Division.
- .3 Relays for Fire Alarm shutdown system control to be approved for Fire Alarm use and powered from the Fire Alarm panel. Fire Alarm relay enclosures to be finished in red and identified "FIRE ALARM RELAY"
- .4 Time delay relays to incorporate time delay feature to delay either opening or closing as specified. Time period to be adjustable from 0 to 5 minutes unless otherwise specified.

Part 3 Execution

3.1 INSTALLATION

- .1 Provide all labour and materials required to complete power wiring for HVAC, Plumbing and Fire Protection equipment as called for in the project specifications and/or shown on the drawings.
- .2 Provide all single and 3 phase motor protection switches, combination starters and disconnects contactors and relays as required for mechanical equipment unless otherwise specifically noted in these specifications or on the drawings.
- .3 Terminate all line voltage wiring to the designated equipment terminals.
- .4 Obtain a full set of HVAC control shop drawings and have a full understanding of the scope before commencing installation and including any fire alarm interface.
- .5 Verify the recommended overcurrent protection and rating of Mechanical and Plumbing and Fire Protection equipment and equipment supplied by the Owner. Change feeder overcurrent protection as required to comply with equipment recommendations. Notify the Consultant of all revisions.

3.2 FIELD QUALITY CONTROL

- .1 Cooperate with Mechanical Consultant and Contractor and check out the operation of all motor controls with all HVAC systems fully operational. Record all electrical loads. Replace any defective or wrongly sized starter overloads, heaters, fuses or circuit breakers.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 00.

Part 2 Products

2.1 SURFACE RACEWAYS

- .1 Removable cover finished painted steel surface raceways.
- .2 Internal barriered to provide physical separation between power and communication cabling.
- .3 Colour to be as indicated on the drawings or where not indicated confirm with Consultant before ordering.
- .4 All raceway fittings to be accessories available from the manufacturer.
- .5 Standard of acceptance:
 - .1 Wiremold 3000 (39mm x 70mm), 4000 (44mm x 121mm), or 6000 (90mm x 121mm), as indicated on the drawings or as required for wiring capacity.
 - .2 Approved equal
- .6 All product to be from the same manufacturer.

2.2 PLUG-IN SURFACE RACEWAY

- .1 Continuous plug-in busway design with an enclosed pathway for power distribution and communication wiring.
- .2 Approved for floor, wall, or ceiling mount.
- .3 Plug-in modules containing receptacles to provide power with circuit breaker protection at the point of use. Plug-in modules can be added to or removed from the Raceway without shutting down power.
- .4 Separate channel to run cabling for voice, data, multi-media, low voltage, and optical fiber cables or other similar items. Snap-on covers to provide access to wiring without removing unit.
- .5 4 pole, (3Ph plus N). 60A continuous surface mounted busway shall use a plug-in type module that allows for the direct plug-in of modules that contain various types of receptacles. Circuit breakers shall be provided as part of the plug-in modules. Short Circuit Rating: 10,000 RMS symmetrical amperes.
- .6 Left hand, right hand, top or rear wire entry points.
- .7 Raceway cover consists of either plug-in modules or blank cover filler sections.
- .8 Standard of acceptance:
 - .1 Starline Plug-In Raceway as manufactured by Universal Electric Corporation.

Part 3 Execution

3.1 SURFACE RACEWAYS

- .1 Where practical provide regularly spaced device outlets and factory pre-cut raceway covers and cover plates. Field install outlets where factory installation is not possible due

to delivery issues or irregularly spaced outlet requirement. In this event covers may be field cut with proprietary factory cover shear equipment with sharp blades.

- .2 Raceways shall be free of burrs inside and out.
- .3 Covers to be matching colour, smooth, free of burrs and parallel with no gaps.
- .4 Preserve and organize the space within the wireway to facilitate multiple wiring runs and future additions. In finished areas and where practical, conduit to feed the surface raceway from a box recessed behind and via grommetted openings to the back of the surface raceway. Maintain pullbox access as required by the Canadian Electrical Code.

3.2 PLUG-IN SURFACE RACEWAY

- .1 Layout drawings of the Raceway system to be approved prior to installation.
- .2 Follow manufacturer's installation instructions.
- .3 Support raceway every 813mm (maximum).
- .4 Provide accessories as required for a complete installation, including insulated bushings and inserts when required by manufacturer.
- .5 Close unused raceway openings using manufacturer's recommended accessories.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 26 05 00.

1.3 RELATED SECTIONS

- .1 Section 26 09 43 Lighting Controls

1.4 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA-C22.2 No.55, Special Use Switches.
 - .4 CSA-C22.2 No.111, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

Part 2 Products

2.1 SWITCHES

- .1 Heavy duty specification grade.
- .2 20 A, 120 V or 347 V, single pole, double pole, three-way, four-way switches as indicated.
- .3 Manually-operated general purpose ac switches as indicated and with following features:
 - .1 Terminal holes approved for No.10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine molding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 White toggle (red toggle for emergency power circuits).
- .4 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rating capacity of motor loads.
- .5 Switches of one manufacturer throughout project.
- .6 Standard of acceptance:
 - .1 Hubbell HBL.1221 20A series
 - .2 Leviton 1221-20A 120V series – 18221 347V
 - .3 Pass & Seymour PS20AC1 120V series – PS37201(3)0 347V

2.2 RECEPTACLES – GENERAL

- .1 Heavy duty specification grade.
- .2 Duplex receptacles, CSA type 5-15R, 5-20R, 125 V, 15 A, 20A, U ground, with following features:

- .1 White nylon molded housing (red for emergency power circuits)
- .2 Suitable for No.10 AWG for back and side wiring.
- .3 Break-off links for use as split receptacles.
- .4 Eight back wired entrances, four side wiring screws.
- .5 Triple wipe contacts and non riveted grounding contacts.
- .3 Receptacles of one manufacturer throughout project.
- .4 Standard of acceptance:
 - .1 Hubbell 5252 heavy duty series
 - .2 Leviton 5262 series
 - .3 Pass & Seymour 5262 series

2.3 RECEPTACLES

- .1 Surge Suppression TVSS 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, blue face, parallel blade, U ground, impact resistant nylon face audible and LED alarm. Equal to:
 - .1 Hubbell 8262SA heavy duty series with LED.
 - .2 Leviton 8280 series
 - .3 Pass & Seymour 8200SP series (Décor)
- .2 Isolated Ground type to be 20 Amp, 125 volt duplex receptacles orange face, impact resistant nylon face.
 - .1 Hubbell IG8262A series
 - .2 Or approved equal
- .3 Ground Fault Interrupter type to be 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, white face, parallel blade, U ground, impact resistant nylon face, complete with breaker and reset button. Equal to:
 - .1 Hubbell GF8200A series
 - .2 Leviton 7599HG series
 - .3 Pass & Seymour HG1595 series (Décor)
- .4 Combination USB Charger Receptacles type to be 20 Amp, 125 volt, 5-20R duplex receptacles c/w one Type A and one Type C USB port. Hospital grade, white face. USB ports rated for over 10,000 insertions. Smart chip technology for optimization of USB charging. Equal to:
 - .1 Leviton T5833-HGW series
 - .2 Or approved equal
- .5 60 Amp 120/208 Volt 4P Pin and Sleeve Receptacle type to be 60 Amp, 120/208V, 4 pole, 5 wire North American pin and sleeve. Industrial grade, certified for current interruption at full rated current. Provide backbox and adapter plate. Equal to:
 - .1 Leviton 560R9W series
 - .2 Or approved equal
- .6 All other single outlet and special purpose receptacles to be similar to the grade and series indicated above. Confirm ampacity, voltage and pin configuration prior to installation.

2.4 DIMMERS

- .1 Flush mounted - Specification grade.
- .2 LED compatible, 0-10V
- .3 Radio interference suppression.
- .4 Thin profile: slide to OFF feature.
- .5 Finished in white or as indicated.
- .6 Acceptable manufacturers:
 - .1 Lutron
 - .2 Leviton

2.5 INTERVAL TIMERS

- .1 Range: 0-30 minutes.
- .2 Spring wound or digital without hold feature.
- .3 Single pole 120 volt, 20 Amp contacts to open at end of timing cycle.
- .4 Flush mounting.
- .5 White finish.
- .6 Standard of acceptance:
 - .1 Wattstopper TS series
 - .2 Intermatic FF51-00
 - .3 Paragon series
 - .4 Leviton 6230M series

2.6 COVER PLATES

- .1 Stainless steel: Type 302 or 304, No. 4 finish, 1mm thick, accurately die cut, protective cover for shipping. To be used on concrete walls.

For all other walls nylon face plates matching device colour shall be used. For general interior flush mounted wiring devices and surface type FS or FD type boxes.
- .2 Steel: sheet steel hot dip galvanized with rolled edges for surface mounted utility boxes.
- .3 Wall plates to be flush mounting with "positive bow" feature to ensure that all edges of plate are flush with wall or surface box when installed.
- .4 All plates to be bevelled type with smooth rolled outer edge and smooth face. Exposed sharp edges are not acceptable.
- .5 Cast metal: die cast profile, ribbed for strength, flash removed, primed with grey enamel finish and complete with four mounting screws to box for special purpose wiring devices.
- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for wiring devices where indicated. Double doors for standard duplex receptacles. Provide cast aluminum weatherproof "While In Use" covers where required by code.
- .7 Gaskets: resilient rubber or close cell foam urethane.
- .8 Cover plates for all wiring devices to be from one manufacturer throughout project.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Mount wiring devices to height specified in Section 26 05 00 or as indicated.
- .2 Upper edge of plates located on separate outlets immediately alongside one another to be at exactly the same height above finished floor.
- .3 All plates to be installed parallel or perpendicular to building lines.

3.2 INSTALLATION PARTICULAR

- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
- .2 Receptacles:
 - .1 Install all receptacles in the vertical plane unless otherwise noted.
 - .2 Generally install the 5-15/20R U ground pin down unless otherwise noted. Neutral up when receptacle in mounted horizontal.
 - .3 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
 - .4 Where split receptacles has one portion switched, mount vertically and switch the upper portion.
 - .5 Surge suppression duplex receptacles to be provided for all communication and computer terminal equipment backboards and cabinets including fire alarm, telephone, public address, door security, nurse call, central dictation, RF television, security television, etc. Provide dedicated neutral conductors for each surge suppression receptacle.
 - .6 Ground fault interrupter duplex receptacles to be used, adjacent sinks or water sources.
- .3 Cover plates:
 - .1 Protect cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 RELATED SECTIONS

- .1 Division 01 - Submittal Procedures.
- .2 Division 01 – Waste Managing and Disposal.
- .3 Section 26 05 00 – Common Works Results for Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA-C22.2 No. 5, current edition, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 PRODUCT DATA

- .1 Submit product data in accordance with Division 01 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with ampacity of 400 A and over with interrupting capacity of 35,000 A symmetrical (rms) and over at system voltage.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for in accordance with Division 01 – Waste Managing and Disposal.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers and ground fault circuit interrupters, and accessory high-fault protectors: to CSA C22.2 No. 5.
- .2 Bolt-on moulded case circuit breakers: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .3 Plug-in moulded-case circuit breakers shall not be permitted.
- .4 Circuit breakers with interchangeable trips where indicated.
- .5 Common-trip breakers: with single handle for multi-pole applications.
- .6 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .7 Moulded-case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
- .8 Solid state trip breakers:
 - .1 Operate moulded case circuit breaker by solid state trip unit with associated current monitors and self-powered shunt trip.
 - .2 Inverse time current trip under overload conditions.

- .3 Provide long time/short time/instantaneous tripping and ground fault short circuit protection where indicated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Provide and locate safety disconnect switches to isolate individual items of equipment in accordance with Canadian Electrical Code CSA 22.1 whether indicated on not on the contract drawings.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International):
 - .1 CAN/CSA C22.2 No.4, Enclosed Switches.
 - .2 CSA C22.2 No.39, Fuseholder Assemblies.

1.3 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Division 01- Health and Safety Requirements.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 - Construction/Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.5 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 00.

Part 2 Products

2.1 DISCONNECT EQUIPMENT

- .1 "Heavy Duty" class, enclosed manual air break switches in non-hazardous locations: to CSA C22.2 No.4
- .2 Fuseholder assemblies to CSA C22.2 No.39.
- .3 Fusible and non-fusible disconnect switch in CSA enclosure.
- .4 Provision for padlocking in off switch position.
- .5 Fuses as indicated. Allow for Class J or L for general circuits, Class RK5 for transformer, motor or other high inrush current circuits
- .6 Fuseholders in each switch suitable without adaptors, for type of fuse as indicated.
- .7 Quick-make, quick-break action.
- .8 ON-OFF switch position indication on switch enclosure cover.
- .9 Provide an auxiliary switch with dry contacts on all elevator disconnects and as required by the Elevator Code. Review elevator shop drawings to confirm any additional requirements.
- .10 Weatherproof as required.

2.2 EQUIPMENT IDENTIFICATION

- .1 Indicate name of load controlled on size 4 nameplate to Section 26 05 00.

2.3 STANDARD OF ACCEPTANCE

- .1 Cutler Hammer
- .2 Schneider -

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses where indicated or required.
- .2 All disconnect switches for elevator machine rooms shall be fused in accordance with the equipment supplier's requirements.
- .3 Provide and locate safety disconnect switches to isolate individual items of equipment in accordance with Canadian Electrical Code CSA 22.1 whether indicated on not on the contract drawings.

3.2 MOTOR PLUG/RECEPTACLE AND QUICK DISCONNECTS

- .1 Motor quick disconnects do not negate the requirement for a switched safety disconnect as specified in this Division. A separate disconnect is still required unless the Consultant has given a special pre-approved circumstance.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Section 26 09 43 – Lighting Controls.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International):
 - .1 CSA C22.2 No.14, Industrial Control Equipment.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.4 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 00.

Part 2 Products

2.1 CONTACTOR EQUIPMENT

- .1 Contactors: to CSA C22.2 No.14.
- .2 Half size contactors not accepted.
- .3 Electrically operated, electrically or mechanically held, multi-pole full voltage type.
- .4 Contactors to have 120V operating (and unlatching) coils unless otherwise noted.
- .5 Controlled by pilot devices as indicated and rated for type of load controlled.
- .6 Breaker or Fused switch combination contactor as indicated.
- .7 Complete with 1 normally open and 1 normally closed auxiliary contacts unless indicated otherwise.
- .8 Provide CEMA enclosure as required for location unless indicated otherwise.

2.2 CONTACTOR REMOTE CONTROLS

- .1 Include following options in cover or in remote locations where indicated:
 - .1 Red LED indicating lamp (incandescent not acceptable)
 - .2 Stop-Start pushbutton or
 - .3 Hand-Off-Auto selector switch or
 - .4 On-Off selector switch.
- .2 Include following remote control options where indicated:
 - .1 Key operated remote control buttons shall heavy duty type, momentary contact, two (2) position spring return to centre, key operated control switch complete with engraved lamicoïd nameplate reading "Off/On". Provide and adjacent standard bullseye type, LED 120 volt rated, red pilot light indicating "power on". Mount pilot light on same faceplate as control switch. Confirm keying requirements (master/submaster) and provide 2 sets of keys.

- .2 Mushroom style "STOP" controls to be heavy duty type, large red button, momentary contact, non latching spring return switch complete with engraved lamicoide nameplate reading "STOP".
- .3 Provide flush mounting boxes and satin stainless steel plates for remote control devices in finished areas. Provide industrial quality, malleable die cast surface mounted units to suit the application classification.

2.3 **EQUIPMENT IDENTIFICATION**

- .1 Indicate name of load controlled on size 4 name plate to Section 26 05 00.

2.4 **STANDARD OF ACCEPTANCE**

- .1 Cutler Hammer
- .2 Schneider

Part 3 Execution

3.1 **INSTALLATION**

- .1 Install contactors and connect auxiliary control devices.
- .2 Pilot lights to be illuminated when contactor is closed.
- .3 Control wire to be minimum #14 AWG. Remote control wiring to be 5A fuse protected and the wiring shall be upsized to limit voltage drop to no more than 2%.
- .4 Control circuits shall fail safe leaving the contactor in the open position if the power fails or where automatic reset could be a safety or operational concern. Provide a control circuit seal-in contact for all momentary contact control devices unless otherwise indicated.
- .5 The contactor shall not automatically reset after a power failure unless otherwise indicated or for such items as automatic freeze protection, snow melting, light control etc.
- .6 Electrically held contactors to be located in service rooms where practical.

END OF SECTION

Part 1 General

1.1 RELATED WORK

1. This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 EQUIPMENT SCHEDULE

1. Unless otherwise noted, values are based on equipment installed up to 150m altitude and operating in ambient temperatures up to 35C.

UNIT G1	G1
Duty	Standby
kVA Rating	
Power Factor	0.8
kW rating	350kW
Voltage (3 phase, 4 wire, 60Hertz)	347/600V
Type of Fuel	No 2 Diesel
Fuel Tank	24-hour Base Tank
Cooling	Radiator
Environment/ Environment	Outdoor
Enclosure	Factory Skin Tight
Silencer Rating	Critical
Battery Charger Supply Voltage	120V single phase
Engine Block Heater Voltage	120V single phase
Starter Battery Bank: DC Voltage	24V
Sound level	Maximum 76dBA at 7m
Equipment Warranty	5 years
Load Bank	Breaker only

1.3 REFERENCES

1. US EPA Tier 2 non-road stationary diesel engine emission control requirements. All equipment should be emissions certified.
2. CSA International
 - .1 CAN ICSA-C282, Emergency Electrical Power Supply for Buildings
3. International Organization for Standardization (ISO)
 - .1 ISO 3046-1-2002, Reciprocating internal combustion engines - Performance - Part I: Declarations of power, fuel and lubricating oil consumptions, and test methods - Additional requirements for engines for general use.
 - .2 ISO 3046-4-1997, Reciprocating internal combustion engines - Performance - Part 4: Speed governing.

4. National Electrical Manufacturers Association (NEMA)
 - .1 NEMA MG1-2006(R2007), Motors and Generators.
5. National Electrical Contractors Association
 - .1 NECA 404, Standard for Installing Generator Sets.

1.4 SUSTAINABLE REQUIREMENTS

1. Materials and products in accordance with Division 01 Sustainable Requirements: Construction.
2. Do verification requirements in accordance with Division 01 Sustainable Requirements: Contractor's Verification.

1.5 WASTE MANAGEMENT AND DISPOSAL

1. Separate and recycle waste materials in accordance with Division 01 and General Conditions.
2. Avoid using landfill waste disposal procedures when recycling facilities are available.
3. Place materials defined as hazardous or toxic waste in designated containers.

1.6 REGULATORY REQUIREMENTS

1. Generator set and auxiliaries shall comply with CSA Standard C282 (latest adopted edition) as well as the following specification.
2. Where this specification calls for performance in excess of CSA C282-15 (latest adopted edition) this specification shall govern.

1.7 SYSTEM DESCRIPTION

1. The generator system shall consist of:
 - .1 Prime mover engine.
 - .2 Alternator.
 - .3 Generator control panel
 - .4 Smart monitoring interface to Building Management System.
 - .5 Muffler and flexible connections.
 - .6 Cooling system.
 - .7 Equipment mounted load bank breaker with shunt trip.
 - .8 Fuel Sub-base tank
 - .9 Fuel pumps.
 - .10 Battery charger and battery
 - .11 Two duplex convenience receptacles
 - .12 Interconnecting wiring.
 - .13 Structural steel base.
 - .14 Automatic transfer switch(es)
 - .15 Weatherproof, factory skin tight enclosure.
2. Set designed to operate as emergency standby power source. Set shall be a packaged unit, complete and mounted on a skid.
3. Control panel to:

- .1 Monitor and control operation of generator.
- .2 Annunciate trouble.
- .3 Sound alarms.
- 4. Generator load start up sequence:
 - .1 Emergency lighting and power
 - .2 Mechanical loads and UPS

1.8 ASSOCIATED WORK

- 1. Concrete pad preparation.
- 2. Installation of anchor devices and setting templates.

1.9 STANDARD OF ACCEPTANCE

- 1. The equipment supplier has not been selected for this section of the specification. Pre-approved alternative suppliers including those listed in Part 2 PRODUCTS "Acceptable Generator Suppliers" will be accepted providing conformance to the base products specified.
- 2. Additional suppliers must be preapproved in accordance with section 26 05 00 'Standard of Acceptance' and "Addition of Acceptable Manufactures'
- 3. All products included must be capable of being verified as a complete system under full warranty by the contractor.
- 4. Supply and install a complete system as the scope of this section.

1.10 SHOP DRAWINGS AND PRODUCT DATA

- 1. Submit shop drawings and product data in accordance with Section 26 05 00.and as outlined herein. All shop drawings items to be within one complete submission.
- 2. Shop drawings to include a complete material list with manufacturer, style, model number and quantity.
- 3. Shop drawings to include manufacturer's specification sheets with photographic depiction of all system components. Specification and descriptive data to include dimension, weight, appearance, connection provisions, materials, metal gauges and operating specification, characteristics, features and controls.
- 4. Provide device samples when requested by the Consultant.

1.11 PRELIMINARY APPROVAL

- 1. Prior to final purchase of the generator set, the following information contained in a binder, shall be submitted for approval:
 - .1 Preliminary dimensioned outline of unit.
 - .2 Confirmation of exhaust pipe diameter.
 - .3 Brake horsepower versus rated speed curves.
 - .4 Fuel consumption and cooling water data.
 - .5 Performance curves for local conditions and multipliers for ambient temperatures.
 - .6 Generator damage curves.
 - .7 Generator decrement curves showing current delivered for specified faults.
 - .8 Generator decrement curves against generator main breaker curve.
 - .9 Efficiency of generator.

- .10 List of components.
- .11 Transfer switch details.

1.12 OPERATION AND MAINTENANCE DATA

1. Provide data for incorporation into maintenance manual specified in Section 26 05 00 and Division 01 and General Conditions. Provide four sets.
2. Operation and Maintenance Manual to include instructions for particular unit supplied and not general description of units manufactured by supplier and:
3. Operation and maintenance instructions for engine, alternator, battery charger, battery, fuel system, engine room ventilation system, cooling system, exhaust system and accessories, to permit effective operation, maintenance and repair.
4. Technical data:
 - .1 Illustrated parts lists with parts catalogue numbers.
 - .2 Schematic diagram of electrical controls.
 - .3 Flow diagrams for:
 - .1 Fuel system.
 - .2 Lubricating oil.
 - .3 Cooling/exhaust system.
 - .4 Certified copy of factory test results.

1.13 MAINTENANCE MATERIALS

1. Provide maintenance materials in accordance with Section 26 05 00.
2. Include:
 - .1 6 fuel filter replacement elements.
 - .2 6 lube oil filter replacement elements.
 - .3 2 air cleaner filter elements.
 - .4 2 sets of fuses for control panel.
 - .5 Special tools for unit servicing.
 - .6 2 sets of approved headphone style ear protectors.

1.14 FACTORY TEST

1. Supplier shall conduct performance and load tests in the factory upon completion of assembly at factory and prior to shipping.
2. Factory full load test to be a minimum of four hours with all test results logged at a maximum of half hour intervals.
3. Test data to include all items listed below in the "Site Acceptance Test".
4. Notify consultant at least two weeks before the scheduled factory test and provide the option to witness. Testing must be done with the unit installed in the enclosure.
5. Copies of certified test results shall be submitted upon completion of factory test procedure.

1.15 ACCEPTANCE TEST (FINAL ON-SITE TESTING)

1. A satisfactory acceptance test shall be conducted after preliminary runs and tests have been made. This test shall be conducted on site after completion of installation. This acceptance test shall not be of less than four hours duration with full rated load on unit. Engine Manufacturer shall provide a 100% portable load bank of full rated load. After completion of above test, tests shall be performed to demonstrate overheat protection, low oil pressure protection and overspeed protection. Miscellaneous valves and piping required to demonstrate functioning of safety devices shall be provided.
2. The following data shall be taken at the start of the test and at half hour intervals thereafter:
 - .1 Frequency.
 - .2 Voltage.
 - .3 Load (amperes).
 - .4 Kilowatts.
 - .5 Water temperatures (inlet and outlet).
 - .6 Lubricating oil temperature.
 - .7 Lubricating oil pressure.
 - .8 Exhaust stack temperature
 - .9 Ambient temperature.
3. On completion of the site acceptance test the supplier shall perform the following tests and demonstrate the satisfactory operation of the following control devices:
 - .1 High water temp. switch.
 - .2 Low oil pressure switch.
 - .3 Overcranking switch.
 - .4 Overspeed switch.
 - .5 Low water level.
 - .6 Low fuel supply level (main tank and day tank).
 - .7 Low battery voltage level.
 - .8 Provide alignment of any flexible couplings.
4. Note: Before connection to building electrical system phase rotation shall be checked for compatibility.
5. Fuel required for performing diesel-generator acceptance test shall be provided by the engine manufacturer.
6. A competent Diesel-generator expert shall be provided for one working day, at a time convenient to Owners, to instruct Owner's staff in maintenance and operation.

1.16 GUARANTEE

1. Provide a written guarantee, signed and issued stating that the generating set is guaranteed against defects in material and workmanship for a period of 5 years, or 1500 operating hours, whichever occurs first, from the date of the Substantial Performance. All travel and labour costs must be included in the warranty coverage for the full 5 year period.

Part 2 Products

2.1 ACCEPTABLE GENERATOR SUPPLIERS

1. Cullen Diesel Power Ltd
2. Cummins Diesel Power Limited with Cummins Engine.
3. Finning Power with Cat Engine.
4. Simpson Maxwell with Cummins Engine.
5. Kohler
6. MTU Onsite Energy
7. Generac

2.2 GENERAL GENERATOR CONSTRUCTION

1. Mount on common steel rail base. Provide spring isolators between generator mounting frame rails and sub-base fuel tank, plus neoprene pads between sub-base fuel tank and concrete pad for vibration isolation.
2. Provide semi-flexible couplings in all pipes and ducts and between generator and engine. Provide protective guards over moving parts. Where flexible hosing is utilized it shall be braided metal type or high pressure silicon rubber. Rubber hose is not acceptable.
3. Machine enamel finish to be manufacturer's standard colour.
4. Provide battery starting system.
5. Provide electric solenoid fuel shut-off valve.
6. Vandal/Weather Proof enclosure.

2.3 GENERATOR COMPONENTS

1. Generator output wiring: 3 phase, 4 wire, with leads as required for 347/600VAC operation, 60 Hz, grounded star. The neutral or star point not to be coupled to the generator chassis. All leads are to be clearly identified.
2. Permanent magnet rotary exciter connected to the generator with external solid state voltage regulator, Basler or approved equivalent. Regulation not to exceed plus or minus two percent from "No Load" to "Full Load". The "No Load" voltage to be adjustable by plus or minus 10 percent. The voltage steady state band width not to exceed plus or minus 0.5 percent. The voltage regulator not to permit the generator output voltage regulation once set, to exceed (wander more than) 1.5 percent.
3. Withstand: generator to be braced for maximum self-generated fault capability whether 3 phase or line to ground, for one cycle minimum. The exciter to provide field forcing during fault conditions and loss of excitation allowing generator breaker to clear the fault before reaching generator damage decrement curve. Provide with shop drawing submission the generator transient, subtransient and zero sequence reactance.
4. Generator shall be designed with a relay logic built in to start the loads typically 3 -5 seconds automatic.

2.4 LOAD BANK

1. Provide a second breaker for a portable electrical resistive load bank for full load testing.

2.5 ENGINE FUEL

1. Engine sized to operate on No. 2 diesel fuel at sea level, at an ambient temperature of 30°C.
2. Provide water separator "duty" and "standby" filters with full bypass/alternative control.

3. All tanks provided by the Division to be full of fuel after site testing and certification. Provide fuel as required.

2.6 GENERATOR BASE TANK

1. Provide a skid mounted double wall steel fuel tank with fuel leak monitoring. Capacity to be for 24 hours runtime at 100% of standby rating.
2. Connection from the tank via electrical solenoid valve to the engine to be flexible. All flexible hoses to be braided metal type.
3. Tank to be steel construction, rust preventive interior coating, rust proofed paint.
4. Provide a fuel level gauge and the following alarms to be annunciated on the generator control panel:
 - .1 Fuel level gauge
 - .2 Pump control
 - .3 High level warning
 - .4 Low level warning
 - .5 Low level shutoff
 - .6 Fuel in rupture basin – Leak detection.
5. All signals to be indicated by LED lights. All signals to have N.O. and N.C. contacts for remote annunciation.
6. Tank to be of 12-gauge steel construction, rust preventive interior coating, rust proofed paint.

2.7 ENGINE DESIGN/COMPONENTS

1. Engine: 4-stroke cycle, radiator cooled, replaceable wet liners, cylinder inspection ports. rating utilized for engine to be the net shaft brake horsepower, taken with all accessories including flywheel, circulating pump, radiator fan, muffler, air filter and all other power consuming equipment allowed for.
2. Capacity: The brake horsepower of the engine shall be not less than that determined by the following formula: Brake Horsepower = $([A/(0.746B)] + C) \times 1.1$. Where A = generator power: i.e. the maximum power (kW) required to be delivered by the generator under normal operating conditions and including both load inrush power (e.g. during motor starting) and radiator fan power. B = generator efficiency, i.e. the efficiency at rated load and power factor. C = loads due to accessories (kW).
3. Voltage dip to meet ISO 8528-5 Class G2 transient performance requirements when full load is dropped on to the machine. Size horsepower to suit.
4. Governor: precision type electronic constant speed to maintain a steady state bandwidth 0.25% +/- at any constant load from "No Load" to "Full Load". Governor to incorporate overspeed safety shutdown. When "Full Load" is thrown on, maximum frequency dip/overshoot not to exceed 10 percent and voltage and frequency to recover to normal regulation within 8 seconds.
5. Immersion (Block) Heater: located in cooling jacket of engine, thermostatically controlled. Heater shall be circulating type.
6. Accessories: provide all replaceable type oil filters, dry type air cleaners, lubricating oils and greases, anti-freeze, etc. All blowout lines to be extended down to floor mounted metal drip pan.
7. All engine sensors i.e. oil pressure, temperature, etc. to be clearly identified with brushed aluminum or stainless steel nameplates.

2.8 SPEED GOVERNOR

1. Provide full electronic governor with speed changer and dry type actuator.
 - .1 Governing system: in accordance with ISO 3046-4.
2. Governor with following features:
 - .1 Ten turn locking type manual speed adjustment.
 - .2 Speed regulation, steady state, no-load to full load and vice versa: +/-0.25%.
 - .3 Transient peak, no-load to full-load and vice versa +/-10%.
 - .4 Recovery time to steady state condition on application of 80% from no load not to exceed 3 seconds.
 - .5 Frequency: externally adjustable from zero to 5% while engine is running.
 - .6 Class A accuracy.

2.9 COOLING COMPONENTS

1. Engine: radiator liquid cooling system complete with horizontal pusher type fan maintaining safe operating temperature for unit under full load conditions in 40 degrees Celsius ambient.
2. Coolant: glycol base anti-freeze good to minus 37 degrees Celsius.
3. Coolant Level: provide low level sensor on radiator with contact wired back to engine/generator control panel and engine trouble common alarm relay.
4. Provide flexible connection to radiator.
5. Provide 50 mm diameter minimum sight glass on radiator to give indication of coolant level.
6. Radiator frame to be flanged to accept canvas ducting.
7. Radiator fan to have safety guard around propeller and drive shaft.

2.10 EXHAUST COMPONENTS

1. Silencer and piping: provide single silencer system, completely sealed, metal primed finish with high temperature paint, insulated for noise and heat radiation. Silencer to be supplied by emergency generator manufacturer and meet the following noise level criteria.
2. Silencer shall meet or exceed specified emissions exhaust standards.

2.11 STARTING SYSTEM COMPONENTS

1. Battery Bank: DC, lead acid type, 5-year life or 200 total discharges, sized for four consecutive starts without additional charging and shall not impede control voltage even after fourth starting attempt. Batteries to be mounted within a plastic battery box and installed on a steel rack attached to engine baseplate.
2. Battery Charger: constant potential type with manual and automatic control, automatic equalize with adjustable timer mounted on wall adjacent to unit complete with DC ammeter, voltmeter, overload protection, AC input switch, pilot light for AC "on", equalizing charge and high rate charge. System to be complete with low and high battery alarm, AC failure, inverter failure, common alarm output contact, all wired to engine control panel for charger failure alarm. Unit to be capable of full charging discharged battery in period not exceeding 24 hours.

2.12 ALARM AND ANNUNCIATOR SYSTEMS

1. Provide a local audible and visual alarm in accordance with Section 46 of the Canadian Electrical Code, CSA C282, and electrical inspection authority and as indicated in this section.
2. Provide dry contacts clearly identified for the "**Building Fire Alarm Supervision**" as per CAN/ULC S524 which requires "a common fault indication from an engine driven generator that is associated with the Fire Alarm".
3. Provide code gauge metal enclosure complete with hinged cover on unit frame mounted above generator to house engine and generator controls or as indicated.
4. Annunciator to be a latching type with manual reset button for DC operation from battery bank incorporating contacts for remote annunciator indication or communication line to generator set controller. All alarms to be silenced by acknowledge button. All subsequent alarms to sound alarm horn. Annunciator to stay illuminated until fault is cleared and reset button depressed.
5. Minimum requirements:
 - .1 Designed for use in harsh environments
 - .2 Audible alarm horn rated at 80 db
 - .3 Surface or flush mounting
 - .4 Lamp test and alarm silence switches
 - .5 Alarms
 - .6 Switch not in auto
 - .7 Low coolant level
 - .8 High coolant temperature
 - .9 Low oil pressure
 - .10 Over-crank
 - .11 Over-speed
 - .12 Emergency stop
 - .13 Fuel Leak
 - .14 Battery over-voltage
 - .15 Weak battery or Battery failure
 - .16 Battery charger trouble.

2.13 REMOTE ANNUNCIATOR

1. Provide a remote LED annunciator in a supervised location or as indicated. Flush or surface mount to suit location. Audible beeper horn with silence button for run and trouble situations. Typical 100x100 standard box mounting.
2. Remote annunciator to indicate:
 - .1 Generator Normal
 - .2 Generator Run
 - .3 Generator Trouble.
 - .4 Individual alarm indications as listed in section 2.12.5 above.

2.14 ENGINE/GENERATOR CONTROL PANEL

1. Engine Controls: Provide oil pressure gauge, oil temperature gauge, water temperature gauge, RPM meter, engine-run relay, engine-trouble relay and fail-to-start relay. Provide 3 spare normally open contacts on engine run relay and 2 spare contacts for engine trouble and fail to start relays all wired to terminal blocks in panel for remote connection.
2. Generator Controls: Provide digital display control panel with voltmeter, ammeter & frequency meter, running time meter. Provide RUN-OFF-AUTO controls on control panel. Controller menu to display power readings in kW, kVA and kVAR. Include alarm log and event log for maintenance and troubleshooting purposes.
3. Provide vibration isolation for engine generator control panel where mounted on unit.
4. Provide clips over all auxiliary relays to secure mounting.

2.15 ENGINE ALARM PANEL

1. Incorporate in engine/generator control panel, generator Off/Start/Auto selector switch key operated, key removable in auto position, timing relays, trouble horn, acknowledge and reset switches and pilot light illuminated annunciators with engraved faceplates reading:
2. Two (2) spare alarm points.
3. Fail to start alarm.
4. Low glycol level alarm.
5. Low oil pressure alarm.
6. Low oil pressure shut down.
7. Low coolant temperature.
8. Low fuel alarm. (Day Tank Only)
9. High water temperature alarm.
10. High water temperature shut down.
11. Overspeed shut down.
12. Over cranking shut down.
13. Battery charger trouble.
14. Provide 2 spare common alarm contacts wired to terminal blocks for remote tie-in to Building Automation System.
15. Provide lamp test button. Alarm lights to be yellow, shutdown lights to be red. Lights shall be LED type.

2.16 GENERATOR BREAKER

1. Moulded case solid state trip breaker.
2. Adjustable trip functions: Provide electronic LSI breaker with adjustable long time delay, instantaneous and short time pick up settings.
3. Auxiliary switch contact
4. Approved Manufacturer: Cutler Hammer RD series, approved equivalent.

2.17 GENERATOR WEATHERPROOF OUTDOOR ENCLOSURE

1. The generator set shall be provided with a factory skin tight enclosure, with the entire package listed under UL2200, and with CSA approval. The generator will be in Whitehorse, Yukon and should be suitable for the local environment. The package shall comply with the requirements of the Canadian Electrical Code for all wiring materials and

component spacing. The total assembly of generator set, enclosure, shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of -40 deg C to +30 deg C. The Enclosure temperature will be kept at minimum +12 deg C when the generator is not running.

2. Provide an exterior platform and stairs to access the generator for maintenance if required.
3. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable, and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater, ice and snow accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.
4. All sheet metal shall be primed for corrosion protection and finish painted with a custom colour as selected by the owner. All surfaces of all metal parts shall be primed and painted. All surfaces cleaned to SSPC-SP1, all seams sealed, primed with epoxy primer. The exterior is top coated with semi-gloss polysiloxane paint.
5. Inlet ducts shall include rain and snow hoods.
6. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
7. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.
8. A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.
9. The enclosure shall include the flexible coolant and lubricating oil drain lines that extend to the exterior of the enclosure, with internal drain valves and external radiator fill provision.
10. Acoustical Enclosure: The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in an ambient temperature of up to 40 deg C. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 76 dBA at any location 7 metres from the generator set in a free field environment. The enclosure shall be insulated with non-hydroscopic materials.
11. Two duplex receptacles.

2.18 NAMEPLATES – ENGINE / GENERATOR PANEL

1. All engine mounted nameplates shall be aluminium or brass and attached with mechanical fasteners.
2. Provide nameplates for all relays, lights, switches, engine sensors, meters, gauges, current transformers, potential transformers, fuses, potentiometers.

2.19 AUTOMATIC TRANSFER EQUIPMENT

1. Provide transfer switches for life safety, non-life safety, fire pump, for full automatic and manual operation of the emergency generator
2. The automatic transfer switch to be complete with bypass isolation to permit manual electrical bypass and isolation of automatic transfer switch to facilitate testing and maintenance.
3. Transfer switches to be CSA approved.

4. Transfer switches to be 3 phase, 3 pole, 4 wire, 600 volt. All switches shall be free-standing NEMA 2 steel enclosure with top drip shield. Power contacts to be break before make. Contacts to be readily accessible for easy inspection and maintenance. Switch contacts to be high pressure long-life multi-finger equipped with all necessary arc chutes, arc quenchers and interphase barriers.
5. Provide time delay relays, adjustable from 0 seconds to 1 minute to delay transfer from normal to standby until standby power source has attained 90 percent of rated voltage. Factory set at 1 second.
6. Provide time delay relays to prevent generator start-up on momentary failure of normal power adjustable from one second to 30 minutes, factory set at 3 seconds.
7. Provide time delay relays, adjustable from 0 to 30 minutes, to delay transfer from standby to normal source to allow normal supply to stabilize, factory set at 3 minutes.
8. Provide unloaded cool-down timer adjustable from 0 to 30 minutes, factory set at 5 minutes.
9. Provide spare alarm contacts prewired to terminal blocks for connection to Building Automation System as follows: Provide 2 N.O. spare contacts for remote indication of utility power available. Provide 2 N.O. spare contacts for remote indication of both transfer switch positions, i.e. closed in normal, closed in emergency. Provide 2 N.O. spare contacts for remote indication of generator power available. Integrity of normal, emergency and load power shall be provided via 3 phase voltage sensing relay. Relays to be mounted within 3 phase transfer switch and to provide contact closure on loss of voltage. Contact closure to be adjustable from 50 to 110 percent of nominal. Power to voltage sensing relays to be obtained from transfer switch bussing via P.T.s. The following spare contacts are required for elevator control: Provide 2 N.C. pre-signal contacts which open 20 seconds (adjustable 1 to 30 seconds) prior to generator transfer and automatic retransfer. Pre-signal timer shall not inhibit an automatic transfer.
10. All main contacts to be of silver composition. They shall be protected by arcing contacts. They shall be of the blow-out configuration and of segmented construction.
11. Automatic transfer switches utilizing components of moulded case circuit breakers, contactors, or parts thereof which have not been intended for continuous duty or repetitive load transfer switching are not acceptable.
12. Provide engine test/auto/off/system test selector switch in enclosure door. Provide remote testing capability.
13. Provide bypass isolation switch to isolate the automatic transfer switch. Bypass isolation shall be provided for both the normal and emergency positions. The bypass switch shall also be capable of manual transfers to either the normal or emergency positions with the automatic portion of the transfer switch removed.
14. Provide "reset to normal" switch to bypass delay on retransfer to normal.
15. Provide red, green and amber cluster type LED lights indicating position of automatic transfer switch, connect, test, disconnect position.
16. Provide cluster type LED lights indicating availability of normal and emergency source power.
17. Provide lamp test pushbutton to test all pilot lamps.
18. All door mounted devices shall be operated at 100 VAC or less.
19. All relays to be hermetically sealed type.
20. Acceptable Manufacturers:
 - .1 Asco

- .2 TTI
- .3 Eaton
- .4 Total Power
- .5 Approved alternate

Part 3 Execution

3.1 STARTING SYSTEM OPERATION

1. Stop/Start Sequence: in automatic position, auxiliary contacts in transfer switch initiates starting cycle of unit. Cranking limiter relay to limit cycle to 75 seconds after which if engine fails to start, trouble circuit contacts close, illuminating appropriate trouble annunciator window and locking out starting cycle until manually reset. Cranking circuit shall permit three 15 second crank attempts with 15 second rest between each crank. On starting of engine, starting circuits automatically reset. On resumption of normal power after time delay in transfer switch, load to retransfer to normal supply and following cooldown period engine shall shut down and return to starting condition.
2. Battery charger to be mounted on unit. Provide all interconnecting conduit and wiring from charger to batteries and batteries to engine starting and generator system.
3. Connect charger to nearest 120 volt AC emergency panel. Provide conduit, wire and breakers as required.
4. Automatic Transfer Switch Operation
 - .1 Automatic start-up upon normal power failure. All transfer switches, the control circuits of which shall be connected in parallel such that any switch can initiate stop/start sequence
 - .2 Transfer when standby unit reaches 90 percent of rated voltage.
 - .3 Retransfer to normal supply after time delay, when normal power is resumed and between 90 and 100 % of nominal.
 - .4 Engine cooldown period at "No Load".
 - .5 Engine shutdown.
 - .6 Operating sequence automatically reset.
 - .7 Remote testing capability.
 - .8 Pre-signal to elevator controller prior to operation of transfer switch in either direction.
 - .9 Provision for integrity of power on normal, emergency and load bussing for tie-in to Building Management System.

3.2 GENERAL GENERATOR EQUIPMENT INSTALLATION

1. Locate generating unit and install in location as indicated.
2. Complete wiring and interconnections.
3. Start generating sets and test to ensure correct performance of components.
4. All conduit or pipe connections to engine-generator shall have a flexible section to allow for vibration and noise transmission dampening.
5. Suitably protect all hot spots and moving parts to prevent accidental contact by personnel. Provide conspicuous sign, warning personnel that engine may start automatically at any time.
6. Connect all controls.

7. Demonstrate that new generator trouble is annunciated at the annunciator panel.
8. Perform 4-hour load test and alarms testing in accordance with PART 1.
9. Notify Consultant 10 working days in advance of test date.

3.3 CLOSEOUT ACTIVITIES

1. Carry out demonstrations and training of complete system.
2. Provide familiarization training of operating and maintenance staff as detailed in PART 1.
3. Fuel to be provided by installation contractor in separate contract.

3.4 MAINTENANCE – CLEARANCES

1. Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and CSA-B139.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 REFERENCES

- .1 Canadian Standards Association CSA C22.2 No 190 Capacitors for Power Factor Correction.
- .2 Electrical and Electronics Manufacturers Association of Canada (EEMAC) 6G-1-, Shunt Capacitors

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 00.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 and General Conditions.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

Part 2 Products

2.1 CAPACITORS – AUTOMATIC

- .1 Ratings:
 - .1 The system operating voltage shall be as indicated.
 - .2 The total capacity of the power factor correction unit shall be as shown on the single line diagram. The total kVAr capacity shall be automatically switched in steps of 10 kVAr
 - .3 The capacitor shall be rated for continuous duty at 40 degree C ambient at 3,300 ft (1,000 meters) and below.
 - .4 Total Harmonic Distortion (THD) of 5% of voltage waveforms shall not affect the life of capacitors, contactors or controller.
 - .5 A +/- 10% variation in line voltage shall not affect the life of the capacitor.
- .2 Construction
 - .1 Individual capacitors shall be self-healing utilizing polypropylene as a dielectric with vacuum deposited conductors on the polypropylene as electrodes. Each three-phase capacitor shall be furnished with a UL recognized pressure sensitive interrupter. The interrupter shall disconnect all three phases at the same time to maintain a balanced circuit.
 - .2 Capacitors shall be contained in hermetically sealed metal cans to prevent atmospheric contaminants from shortening the useful life. Dielectric material shall be low loss, less than 0.5 watts per kVAr. Encapsulation medium shall be a thermo setting polymer resin, which allows out gassing to engage the pressure interrupter.
 - .3 Terminal bushings shall withstand 10 kV AC to ground and be rated 30 kV BIL or greater. Nominal design life of individual capacitor cells shall be 20 years. Individual capacitor cells shall be covered by a five-year warranty. All capacitor cells shall have threaded terminals for wire connection.

- .4 All power wiring shall have a thermoplastic insulation rated for 90 degrees C at 600 volts.
- .5 The system wiring connections shall be made to copper bus bars braced for 25,000 amps or greater and the power correction unit shall a modular design.
- .6 Contactors shall be rated for switching of capacitors by the contactor manufacturer.
- .7 The automatic power factor correction equipment shall be warranted by the manufacturer of the capacitor cells.
- .8 Air core transient suppression coils shall be provided in series between the contactors and fuses.
- .9 All wiring connections shall be mechanically fixed with nut or screw.
- .3 Discharge Resistors
 - .1 Capacitors shall be provided with discharge resistors to reduce residual voltage to less than 50 volts within one minute of de-energization. (National Electrical Code Article 460-6). Resistors shall be chosen to ensure a 20 year minimum life.
- .4 Fuses
 - .1 To provide for major fault protection, line fuses shall be provided on all three phases of the capacitor bank.
 - .2 Fuses for 10 kVAr 600 Volt (4 kVAr 240V) and smaller shall be standard midget type with 100 kAic mounted in a phenolic fuse block. Three fuses shall be provided.
 - .3 For 11 kVAr and larger, three fuses shall be provided and shall be standard bolted blade type with 200 kAic. Indication of fuse operation shall be obtained by use of blown fuse lights. Neon lights shall be connected in parallel with the line fuses. When the fuse clears, the light glows.
- .5 Connectors
 - .1 Each assembly shall be furnished with appropriately sized solderless connectors capable of handling conductors in accordance with the NEC. Minimum conductor size shall have the capacity 1.35 times rated capacitor current.
- .6 Enclosures
 - .1 Capacitors shall be provided with enclosures fabricated from #14 gauge steel, minimum. The cover shall be gasketed and "L" shaped with multiple fasteners to provide front opening for ease of installation and service. The enclosure shall be CEMA 1. An internal grounding lug shall be provided. Capacitor cells shall be accessible for visual inspection and replacement from the front of the cabinet. The enclosure shall be provided with pre-drilled hangers for wall mounting.
- .7 Manufacturers
 - .1 Eaton
 - .2 Shneider

2.2 CONTROLS

- .1 All controls shall be mounted on enclosure door for easy inspection and service.
- .2 A door interlock shall be provided to disconnect control power when enclosure door is open.

- .3 A personnel ground fault breaker shall be provided to disconnect control power upon accidental contact with control power and ground.
- .4 On/Off switch shall control power to all door mounted controls. The On/Off switch shall contain pilot light to indicate "on" mode.

2.3 REACTIVE POWER CONTROLLER / POWER FACTOR METER

- .1 Controller shall measure the reactive current on every passage of the voltage through zero.
- .2 A LED display shall be provided to indicate the stages that are on.
- .3 The controller shall be provided with a programmable target cosine selector in the range of .7 lagging to .9 leading.
- .4 The time delay between switching of capacitors must be field programmable and have a range of 5 seconds to 20 minutes to reduce hunting and allow voltage decay as required by NEC.
- .5 All output contacts shall be disabled within 35 milliseconds of main power interruption. The controller shall retain its programming after the restoration of supply voltage. The controller shall bring the capacitor bank back on line in a step, phased, normal sequence.
- .6 Controller shall be able to display power factor with indication for an inductive or capacitive power factor.
- .7 Controller shall provide an option for a remote connection to a PC or printer.
- .8 Controller shall have the ability to calculate and store in memory the kVAr value of each step.
- .9 Controller shall recognize a defective capacitance step and eliminate that step from the circuit.
- .10 Controller shall automatically determine C/K ratio.
- .11 Controller shall indicate insufficient kVAr to achieve target power factor.
- .12 Controller shall have indication of an excessive harmonic condition.

2.4 BLOWN FUSE LIGHTS

- .1 "Push-To-Test" blown fuse pilot lights. One per each fused phase, of 50 kVAr step, shall have its own blown fuse indicating light mounted in close proximity to the fuse for easy identification.

Part 3 Execution

3.1 INSTALLATION

- .1 Install and connect capacitor as indicated.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Following tests to be carried out by manufacturer within 24 hr of energizing equipment:
 - .1 Voltage and current are balanced and within capacity rating.
 - .2 Operating kVAR.
 - .3 Terminal to case resistance is greater than 1000 megohm for two bushing capacitors.
- .3 Submit certified test results.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results for Electrical.
- .2 Section 26 09 43 - Network Lighting Controls.

1.3 REFERENCES

- .1 CAN/CSA C22.1-15, Canadian Electrical Code, Part I.
- .2 CAN/CSA C22.2 No.9.0, General Requirements for Luminaires.
- .3 Canadian Standards Association C22.2 No. 250.0-08 / (c/CSA/us) ANSI/UL Standard 1598, 3rd Edition - Luminaires.
- .4 Canadian Standards Association C22.2 No 250,13-12, (c/CSA/us) 1st Edition - Light Emitting Diode (LED) Equipment for Lighting applications.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 - Construction/Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.5 ADDITION OF ACCEPTABLE MANUFACTURERS

- .1 Note that fixtures noted on luminaire schedule as are to be as specified and alternate luminaires will not be considered.
- .2 Refer to Section 26 05 00 and as noted below.
- .3 **Material/products considered to satisfy the specification, but of a manufacturer other than those named may be submitted to the Consultant for consideration not later than five (5) working days prior to closing of tender or of bid depository subtrade tender whichever is earlier.**
- .4 **Alternate approvals will be given by written addendum only. No other substitution will be permitted after closing of tenders.**
- .5 Alternate approvals granted before the closing of tenders will be limited to a manufacturer's system and/or series only. This limited approval will not preclude substitute equipment/material from complying with specific features included with equipment/material specified. Determine that the alternate product meets the specification intent before basing a tender on the product

1.6 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 26 05 00.
- .2 Where available, shop drawings to include LM-79/80 and TM-21 test data.
- .3 Product Data: Manufacturer's data sheets on each product to be used, including:
 - .1 Canadian Underwriters' Laboratories labeling.
 - .2 Canadian Standards Association labeling.
 - .3 Product Data including Wattage, lumen output, CRI, driver type, etc.

- .4 Fixture Schedule: Manufacturer's standard fixture schedule, coordinated with project requirements and the fixture schedule on the Drawings.
- .5 Sample Luminaires: Full size unit of each fixture type, including lamps, ballasts and supports.
- .6 Operation and Maintenance Data: For each fixture and component, including lamps and drivers.

1.7 SAMPLE LUMINAIRES

- .1 Submit sample luminaires for review prior to manufacturing when requested by the Consultant.
- .2 Sample luminaires to be operable and complete with lamps, accessories and a plug-in power cord if requested by the Consultant.
- .3 Deliver samples to the Consultants office or to another location as directed. Collect the sample(s) at the conclusion of the review.

1.8 JOB MOCK UP

- .1 Allow for time for on-site mock-up, specifically for accent and feature lighting such as coves, glass edge lighting, and wall wash fixtures. A single luminaire will be installed in each area and aimed to confirm exact installation details prior to installing remaining luminaires. Notify consultant 1 week prior to on-site mock up of luminaires.

1.9 PROJECT CONDITIONS

- .1 Coordinate locations of lighting fixtures with ceilings, ceiling mounted components, fire protection and mechanical components, and partitions.
- .2 Maintain environmental conditions within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.10 INTENT

- .1 Provide luminaires and accessories for all locations as listed in the Luminaire Schedule and as shown on drawings.
- .2 Luminaires shall be structurally well designed and constructed, using new parts and materials of the high quality commercial grade.
- .3 Ground all lighting equipment to grounding system.
- .4 Verify all ceiling types and finishes before ordering luminaires and provide luminaires suitable for mounting in or on ceilings being installed in each area, as specified. Where luminaire types specified are not suitable for ceiling being installed, obtain written instructions from the Consultant before ordering luminaires.
- .5 Luminaires of the same or similar type shall be supplied by the same manufacturer.

Part 2 Products

2.1 LUMINAIRES

- .1 Provide luminaires as identified in project luminaire schedule and in compliance with drawings. Provide luminaires and accessories, complete and ready for service, in compliance with relevant CSA and ULc Standards.
- .2 Clearly mark fixtures, in locations not visible after installation, with manufacturer's name and catalog number, voltage, acceptable lamp type (where applicable), and maximum wattage.
- .3 Luminaires to be UL listed for the intended application.
 - .1 Fixtures in outdoor locations exposed directly to weather to be listed for wet locations.
 - .2 Fixtures in soffits and other protected outdoor locations, and fixtures exposed to water and extreme humidity indoor to be listed for damp locations.
- .4 All luminaires and lighting installations shall include easy access to the luminaire and driver for maintenance or replacement of the driver or luminaire in it's entirety.
- .5 All luminaire diffusers, lens panels, lens frames, etc., shall be securely and adequately supported.
- .6 Luminaires shall incorporate adequate gasketing, stops and barriers to form light traps and prevent light leaks.
- .7 Luminaires shall be designed for adequate dissipation of driver and lamp heat to avoid short life, nuisance thermal tripping and decreased lumen output. Heat test reports by independent laboratories shall be provided where required by the Consultant.
- .8 Construction of all luminaires shall be such as to provide a rigid well aligned luminaire. Formed or ribbed backplates, end plates, reinforcing channel, straps, etc., shall be used where required to accomplish this.
- .9 The construction and performance of all luminaires shall be subject to the acceptance of the Consultant. Full photometric data from an independent testing laboratory shall be provided when requested by the Electrical Consultant.
- .10 Incandescent/Fluorescent luminaires with retro-fit LED lamps are not acceptable.
- .11 LED tape light is to be installed in extruded aluminum channel. No LED tape should ever be mounted directly to building structure or finishes. Provide aluminum extruded channel and lens as specified, complete with mounting clips for all LED tape light. Provide all wiring, adequately sized power supplies and control interfaces as required for a fully functioning lighting system.
- .12 All LED product to meet the following minimum specifications:
 - .1 General: Color Rendition – CRI > 80
 - .2 Efficacy – Minimum 100 LPW for linear luminaires, Min 65 LPW for all other luminaires over 5W. No minimum requirement for luminaires 5W or less.
 - .3 Lamp Life – Minimum 50,000 HR L70 lamp life.

2.2 DRIVERS

- .1 Drivers intended for indoor use shall have a rating of IP20.
- .2 Drivers intended for outdoor use shall have a rating of IP67.

- .3 Dimming performance:
 - .1 Drivers to achieve a range from 10-100% dimming. Electrical contractor to confirm dimmer and driver compatibility to ensure specified dimming range is achieved.
- .4 Class 2 per UL1310
- .5 Power Factor Correction >0.9.
- .6 Must be cUL/UL Listed.
- .7 Refer to Network Lighting Control section 26 09 43 for driver types.

Part 3 Execution

3.1 INSTALLATION AND SUPPORTS

- .1 Provide complete and proper support for all luminaires, luminaire hangers, etc., including headers in ceiling space, where required, for proper support of outlet boxes and luminaire hanger assemblies.
- .2 Support luminaires as shown on the drawings, level, plumb and true with the structure and other equipment in a horizontal or vertical position as intended. Wall or side bracket mounted luminaire housings shall be rigidly installed and adjusted to give a neat flush fit to the surface on which it is mounted.
- .3 All hangers, supports, fastenings or accessory fittings shall be protected against corrosion. Care shall be taken during the installation to assure that insulation and corrosion protection is not damaged.
- .4 Self aligning seismically rated ball joint hangers shall be used for rod suspended luminaires. Ceiling canopies or hood assemblies intended to cover the suspension attachments shall be installed to fit tightly to the ceiling without restricting the alignment of the hanger. Support luminaires by hangers and mounting arrangements which will not cause the luminaire frame, housing, sides or lens frame to be distorted; or prevent complete alignment of several luminaires in a row.
- .5 The suspension length of all ceiling mounted suspended types of lighting luminaires as listed in the Luminaire Schedule or annotated drawings shall be the overall length from the ceiling to the lowest point of the luminaire body, reflector or glassware in its hanging position. Mounting heights listed as AFF to be above finished floor to the center point of the luminaire.
- .6 Metal inserts, expansion bolts or toggle bolts in concrete slabs for stems which do not carry wiring must be accurately located in relation to the outlet boxes, to allow perfect alignment and spacing of suspension stems.
- .7 Where luminaires are surface mounted on the underside of an inverted tee bar ceiling, the luminaire shall be supported either directly from the building structure by means of rod hangers and inserts or by means of metal angle headers, supported from the tee bar framing structure above the tile. Luminaires shall be supported from the quarter points.
- .8 Wiring from outlet boxes to luminaires and wiring through luminaire channels shall be rated for 90 degrees C.
- .9 All recessed luminaires to be installed so that they are removable from below to gain access to outlet box or prewired luminaire box. Connect all recessed luminaires to boxes with flexible conduit and approved luminaire wire. Provide approved drywall enclosures in insulated ceilings. Volume of enclosure to comply with Electrical Code.
- .10 Install luminaire lenses as late as possible to protect from dirt and dust. Remove and clean or replace lenses to the satisfaction of the Consultant.

- .11 Where drivers and power supplies are to be remotely located, they shall be racked together and labelled with size 3 lamicaid. Label shall bear the driver number which has a corresponding location on an adjacent floor plan reference drawing. Labels and floor plans shall be provided by electrical contractor.
- .12 For LED tape light luminaires, allow for all labour associated installation of factory-cut and terminated sections into site-cut extruded aluminum channel, installation of lens, mounting, adjustment and aiming of luminaire, as well as all power supplies, control devices and associated 120V and low voltage DC wiring.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 and General Conditions.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 00.
- .2 Shop drawings to include a load schedule on each battery pack and spare capacity.

1.4 GUARANTEE

- .1 Provide a written guarantee, stating that the battery for emergency lighting is guaranteed against defects in material and workmanship for a period of ten years, with a no-charge replacement during the first five years and a pro-rate charge on the second five years, from the date of the Final Certificate of Completion.

Part 2 Products

2.1 BATTERY UNIT EQUIPMENT

- .1 Unit equipment for emergency lighting: to C22 C22.2 No.141.
- .2 Supply voltage: 120 V, ac.
- .3 Output voltage: 12 V dc.
- .4 Operating time: 30 minutes.
- .5 Nominal size – 360 watt.
- .6 Battery: lead acid, sealed, maintenance free.
- .7 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected, modular constructed.
- .8 Solid state transfer.
- .9 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .10 Signal lights: solid state, life expectancy 100,000 h minimum, for 'AC Power ON' and 'High Charge'.
- .11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Provide shelf mounting brackets.
- .12 Provide integral self-diagnostic testing feature which exercises the unit every 30days.
- .13 Auxiliary Equipment:
 - .1 Test switch.
 - .2 Time delay relay.
 - .3 Shelf bracket.
 - .4 Cord and plug connection for ac.

- .5 Double quartz lamp fixtures mounted on unit where noted on plans.
- .6 Units to be finished in white.
- .14 Standard of Acceptance:
 - .1 Readylite "LDX" series
 - .2 Beghelli "Nova" series

2.2 REMOTE LAMP HEADS

- .1 7 watt LED
- .2 12 volt DC operation.
- .3 Acceptable Manufacturers:
 - .1 Readylite "RM" series
 - .2 Beghelli "SR PAR18" series

2.3 WIRING FOR REMOTE EQUIPMENT

- .1 Conduit to Section 26 05 34
- .2 Wiring 12V battery standby circuits to all EXIT signs and remote heads.
- .3 Low voltage wiring to be installed so that the maximum volt drop does not exceed 5%.
The following wiring/load sizes shall not be exceeded for the 12-volt system:
 - .1 #8 AWG not to exceed 6500 watt feet per run.
 - .2 #10 AWG not to exceed 4000 watt feet per run (minimum size).

2.4 RELAY EQUIPMENT

- .1 Provide 120V relays to control battery packs as required by BC Building code to operate in the event of power failure to the related area lighting circuits.

Part 3 Execution

3.1 INSTALLATION

- .1 Install unit equipment for emergency lighting in accordance with CSA C22.1, Section 46.
- .2 Install unit equipment and remote mounted fixtures as indicated.
- .3 Direct heads as indicated.
- .4 Provide a junction box adjacent to the battery pack for the purpose of splicing the separate wiring runs together.
- .5 Provide a 15 Amp, 125 volt receptacle adjacent to each battery unit.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 REFERENCES

- .1 Canadian Standards Association:
 - .1 CSA C22.2 No.141, Unit Equipment for Emergency Lighting.
 - .2 CSA C860, Performance of Internally-Lighted Exit Signs.
- .2 BC Building Code, Part 3, Section 3.4.5.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 26 05 00.

Part 2 Products

2.1 SCHEDULE

- .1 Refer to drawings for location and types. Provide directional signs as indicated.

2.2 EXIT SIGNS GENERAL

- .1 Green “running man” pictogram.
- .2 Universal mounting.
- .3 Wall, end, or ceiling mounted as shown on drawings.
- .4 Single or double-faced as indicated
- .5 Light Emitting Diode (LED) light source for 120 volt operation. Less than 3 watt consumption per face.
- .6 Extruded aluminum housing. Housing depth to be maximum 63 mm.
- .7 Faceplate and housing to have no visible unused knockouts.
- .8 Provide weatherproof exit signs for all exterior installations.
- .9 CSA 860 (latest version) approved.
- .10 Standard of acceptance:
 - .1 Ready-Lite
 - .2 Beghelli

2.3 SPARE EXIT SIGN MATERIAL

- .1 Refer to Appendix E2 Electrical **Form EF140** for Spare Material hand over requirements to Owner.
- .2 Provide four spare Exit Signs
- .3 Include in base tender to install the “spare” Exit Signs in locations as directed by the Consultant. Include for the installation and up to 30m of wiring for each spare Exit Sign. The unused Exit Signs to be handed over as spare material.

Part 3 Execution

3.1 INSTALLATION

- .1 Install Exit Signs as indicated.

- .2 Connect Exit Signs to dedicated circuits and breakers as required by the Canadian Electrical Code.
- .3 Provide circuit breaker locks for Exit Sign circuits.
- .4 Power to exit lights to be sourced from emergency power where available.
- .5 Provide at least one Exit Sign circuit for each floor level except as noted.
- .6 All Exit Sign wiring to be installed in separate conduit and boxes.
- .7 All conductors to be minimum #12 AWG with RW90 X-link insulation.
- .8 Provide Exit Sign 12VDC standby lighting and separate connection points where standby emergency lighting battery packs are used for the emergency lighting. For remote connections low voltage cable sizing refer to the battery systems specification section.
- .9 Support Exit Signs from ceiling tile in tee bar installation locations so as to provide a flush/neat installation and minimize tile lift.
- .10 Provide approved support hardware to the tee bar rail assembly to minimize tile stress and provide independent seismic cable(s) restraint from building structure.
- .11 Wall mounted exit lights to be mounted 2290mm to underside or as detailed.
- .12 Ceiling mounted exit lights in all service spaces to be suspended to 2290mm to the underside.

3.2 FINAL ACCEPTANCE

- .1 Position exit lights to optimize viewing angles and to avoid line of site obstructions.
- .2 Attend the building occupancy review with the Authority Having Jurisdiction and adjust any locations as required.
- .3 Install any additional exit signs as requested in accordance with "Spare Exit Sign Material" clause noted above.

END OF SECTION

1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.1 All of Division 27 specifications.

.2 Division 28:

.1 28 13 00 Access Control

.2 28 16 00 Security and Access Control Systems

.3 28 23 00 Video Surveillance Systems

.4 28 25 01 Panic and Emergency Phone Devices

1.2 LIST OF ABBREVIATIONS

.1 The following abbreviations may be used within this specification document and in the drawings.

.1 AHJ: Authority Having Jurisdiction

.2 ANSI: American National Standards Institute.

.3 ASTM: American Society for Testing and Materials

.4 BICSI: Building Industry Consulting Service International

.5 CATV: Cable TV

.6 CP: Consolidation Point

.7 CSA: Canadian Standards Association – equipment safety approvals and testing for Canada

.8 EF: Entrance Facility

.9 EGB: Electrical Ground Breaker

.10 ETL: ETL Testing Laboratories – product testing laboratory for U.S. and Canada

.11 FDC: Fiber Distribution Centre (Fiber splice tray or termination tray)

.12 IDF: Intermediate Distribution Frame

.13 IEEE: Institute of Electrical and Electronic Engineers

.14 ISO: International Standards Organization

.15 MEGB: Main Electrical Ground Busbar

.16 NEMA: National Electrical Manufacturer's Association

.17 PBB: Primary Bonding Busbar

.18 MER: Main Equipment Room (Typical location of Network Core Switches)

.19 EF: Entrance Facility

.20 TR: Local Telecommunications Room

.21 SBB: Secondary Bonding Busbar

- .22 TO: Telecommunications Outlet
- .23 ULC: Underwriters Laboratories of Canada – testing laboratory for Canada (see C- UL and UL)
- .24 UTP: Unshielded Twisted Pair
- .25 WA: Work Area

1.3 OVERVIEW

- .1 These standards and specifications prescribe minimum mandatory requirements for communications infrastructure within all buildings, up to and including the Telecommunications outlet, and between buildings to the extent of a region and province wide environment.
- .2 A structured approach is specified which will ensure a flexible distribution system that will minimize the future costs of moves, additions and changes.
- .3 Communications Systems Contractor will supply, furnish, and install: all material, labour, apparatus, tools, equipment and services required for construction and put into regular operation the complete Communications system, as shown on the Telecommunications Drawings, described in the specifications and any attached appendices.
- .4 There are administrative and documentation requirements in this section that also apply to electronic security systems in Division 28.

1.4 REFERENCED CODES AND STANDARDS

- .1 Comply with the latest British Columbia Building Code, and Canadian Electrical Code, including all provincial and other amendments, any local by-laws or rules and regulations requirements of the Owner.
- .2 Equipment and materials shall bear the approval of the Canadian Standards Association and where applicable, the Underwriters Laboratories of Canada or alternately shall bear local approval from the Electrical Inspection Department having jurisdiction. Include in the contract all costs associated with obtaining local approvals.
- .3 If there is a conflict between the Drawings and Specifications and the above noted codes, by-laws, rule and orders, the codes, by-laws, rules and orders shall govern. In no instance, however, shall the standards established by the Contract Documents be reduced by any of these codes or regulations.
- .4 Install and test telecommunications cabling networks as per the latest manufacturer's requirements and in accordance with the following standards:
 - .1 ANSI/TIA Standards.
 - .2 ANSI/TIA 568-D.1-2015 Generic Telecommunications Cabling for Customer Premises standard.
 - .3 ANSI/TIA -568-0-D-2015 Commercial Building Telecommunications Cabling Standard
 - .4 ANSI/TIA-568-C.2-2009 Commercial Building Telecommunications Cabling Standard – Balanced Twisted Pair Cabling Components.
 - .5 ANSI/TIA-568-C.3-2008 Optical Fiber Cabling Components Standard.

- .6 ANSI/TIA-569-D-2015 Commercial Building Standard for Telecommunications Pathways and Spaces.
- .7 ANSI/TIA/EIA-606-C-2017 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- .8 J-STD-607-C-2015 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- .9 ANSI/TIA-570-C-2012 Residential Telecommunications Cabling Standard.
- .10 ANSI/TIA-758-B-2012 Customer Owned Outside Plant Telecommunications Cabling Standard.
- .11 ANSI/TIA-4966-2014 Telecommunications Infrastructure Standard for Educational Facilities.
- .12 ANSI/TIA-942-A-2012 Telecommunications Infrastructure Standard for Data Centers.
- .13 ANSI/TIA-TSB-162-2013 Telecommunications Cabling Guidelines for wireless Access Points.
- .14 The Canadian Electrical Code Part 1, C22.1-18 edition.
- .15 BC Amendments to the CEC and associated bulletins.
- .16 IEEE 802.3 series of Ethernet Standards.
- .17 IEEE 802.11 series of Wireless Standards.
- .18 ISO 8802-3 series of Standards.
- .19 BICSI latest technical manuals:
 - .1 ANSI/BICSI 002-2014, Data Centers Design and Implementation Best Practices.
 - .2 ANSI/BICSI 003-2014 Building Information Modeling (BIM) Practices for Information Technology Systems
 - .3 ANSI/BICSI 004-2012, Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - .4 ANSI/BICSI 005-2013, Electronic Safety and Security (ESS) System Design and Implementation Best Practices
 - .5 ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
 - .6 NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - .7 Information Technology Systems Installation Methods Manual
 - .8 Network Systems and Commissioning (NSC) reference
 - .9 Outside Plant Design Reference Manual 5th Edition
 - .10 Telecommunications Distribution Methods Manual 13th Edition

- .11 Electronic Safety and Security Design Reference Manual
- .5 Conform to current safety and security standards, codes, and practices in effect at Health Authorities including, but not limited to:
 - .1 Workers Compensation Act – Part 3 – Occupational Health & Safety.
 - .2 BC Electrical Safety Act.
 - .3 The British Columbia Building Code with Amendments.
- .6 If there is conflict between any of the ANSI/TIA or BISC1 referenced standards, ANSI/TIA takes precedence.

1.5 APPLICATION STANDARDS

- .1 The Certified Structured Cabling System shall be guaranteed to operate the applications which the System was originally designed to support, as well as any new applications. New applications are defined as any application introduced in the future by recognized standards organizations or user forums that use the TIA-568-C or ISO/IEC IS 11801 component and link/channel specifications for cabling.

1.6 MANUFACTURER'S CABLING SYSTEM APPLICATION WARRANTY

- .1 An applications Warranty shall be issued to guarantee that the Telecommunications Wiring Infrastructure shall support up to, but not limited to 1000Base-T applications or 10GBASE T (10GbE) over twisted-pair copper cabling) for Cat.6A solutions.
- .2 All cabling products and workmanship must include coverage as follows:
 - .1 System Application Warranty from Manufacturer.
 - .2 System Performance Warranty Certificate must be provided by the Subject Warranty Manufacturer.
 - .3 The System Application Warranty term must be a minimum of 25 years provided by the Warranty Underwriting Manufacturer, from the date of final acceptance of the project.
 - .4 The name and address of the building/facility and location of site must appear on the warranty document.
 - .5 The Communications Systems Contractor must be fully approved and certified by the proposed Warranty Underwriting Manufacturer prior to responding to the bid as a pre-qualification.
 - .6 Testing shall be performed by Telecommunications Technicians who are qualified to perform related tests as required by the manufacturer in accordance with the manufacturer's methods. The successful Contractor shall also provide proof of competency for the installers that will be working on the system on site.
 - .7 The original 25 Year Warranty Certificate from the Manufacturer's shall be submitted to the Owner.

1.7 DRAWINGS

- .1 The location of various items indicated in drawings, are approximate except where specifically mentioned.
- .2 Drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of work.
- .3 The Communications Systems Contractor is responsible to take field measurements where equipment and material dimensions are dependent upon building dimensions.
- .4 The Communications Systems Contractor will coordinate with General, Mechanical and Electrical trades as well as Furniture Layout Designer for final user outlet locations.
- .5 If any discrepancies or omissions are found in the drawings, or if the intent is not clear, the Communications Systems Contractor will obtain clarification from the Consultant.

1.8 SHOP DRAWINGS, SUBMITTALS AND CONSTRUCTION DOCUMENTS

- .1 The Communications Systems Contractor will submit to the Consultant for review all product data (including cut sheets and catalogue information) and shop drawings for the project noting long lead-time items and providing samples and mock-ups if required by the Contract Documents.
- .2 The Communications Systems Contractor will submit a sample binder and contents of the Manual of Operations for approval at time of shop drawings submission. Refer to Substantial Performance for further details.
- .3 The Communications Systems Contractor will also present the following submittals to the Consultant for review:
 - .1 Manufacturer's catalogue sheets and specifications for fiber optic field-test instruments including optical loss test sets (OLTS; power meter and source), optical time domain reflectometer (OTDR) and inspection scope.
 - .2 Sample test reports.
 - .3 Backbone cable routing or location changes.
 - .4 Fire-stop design, identifying all locations to be fire-stopped, complete with documentation, a list of all fire-stopping materials to be used, and fire-stop systems to be installed.
 - .5 Commissioning Plan
- .4 All above submittals must be forwarded promptly and in such sequence as to cause no delay in the work or in the activities of the other trades.
- .5 The Consultant will indicate approval of shop drawings, product data, and samples submitted by stamping such submittals with the word: "REVIEWED".
- .6 Submitted shop drawings will be signed by the Communications Systems Contractor, imprinted with the date submitted, and will bear the Communications Systems Contractor's legitimate Company name.

- .7 By submitting shop drawings, product data, and samples, the Communications Systems Contractor signifies that he, or she has carefully reviewed and verified materials, quantities, field measurements, and related field construction criteria. It also signifies the Communications Systems Contractor has checked, coordinated, and verified that all information contained in shop drawings, product data, and samples conforms to the requirements of the Work and of the Contract Documents.
- .8 The Communications Systems Contractor will perform no portion of the Work requiring submittal and review of shop drawings, product data, or samples until the Consultant has reviewed the respective submittal.
- .9 The Communications Systems Contractor will submit shop drawings, product data, and samples to the Consultant
 - .1 For initial and re-submission for approval, the Communications Systems Contractor will submit a soft copy of the proposal that is electronically stamped to the Consultant.
 - .2 The Communications Systems Contractor will highlight relevant products on the shop drawings.
 - .3 The Consultant will not accept illegible submittals.
- .10 Shop Drawings shall be provided for:
 - .1 Copper Cabling
 - .2 Fiber Cabling
 - .3 Coaxial Cabling (DAS system)
 - .4 Fiber Connector Housings
 - .5 Faceplates
 - .6 Ceiling boxes
 - .7 Floorboxes
 - .8 Jacks/Inserts
 - .9 Patch Panels
 - .10 110 Punch Block System (Gigabix)
 - .11 Fiber Connectors
 - .12 Equipment Racks, Cabinets and Enclosures
 - .13 Vertical and Horizontal Cable Management
 - .14 Cable Tray
 - .15 Firestop Details (Product and System Number)
 - .16 Telecommunications Bonding and Grounding System Materials
 - .17 ePDUs
 - .18 Clocks

- .11 The submittals shall be reviewed for general compliance and not for dimensions, quantities, etc. The submittals that are returned shall be used for procurement. The responsibility of correct procurement remains solely with the Communications Systems Contractor. The submittal review shall not relieve the Communications Systems Contractor of responsibility for errors or omissions and deviations from the Contract requirements.
- .12 Equipment and material substitutions are prohibited. If the submittal shows variations from the requirements of the Contract Documents for any reason, the Communications Systems Contractor shall provide written detail of each variation in the letter of transmittal.
- .13 All approved equivalent products shall be submitted prior to tender closing.
- .14 Shop Drawings shall be submitted in an electronic format on USB Memory Key. The file format shall be Adobe portable data file (.pdf).

1.9 AS-BUILT DOCUMENTATION

- .1 The as-built drawing package shall have all elements in all floor plan, elevations, sections, and isometric views updated to as-built conditions by the Communications Systems Contractor. In addition, all schematics and risers shall be updated by the Communications Systems Contractor.
- .2 The Communications Systems Contractor will provide Maintenance Manual containing the following:
 - .1 Set of final reviewed Shop Drawings.
 - .2 Full size set of As-Built drawings
 - .3 (3) USB Memory Keys of As-Built drawings in PDF format (all files combined into a single document).
 - .4 Digital photos of all Communications Rooms showing each wall and rack elevations.
 - .5 Digital photos of all Electronic Security System equipment installed in racks or cabinets.
 - .6 Circuit Spreadsheets for horizontal cabling and fiber backbone.
 - .7 Manufacturer Warranty documents for equipment and workmanship.
 - .8 Copper Warranty Certification test result printouts.
 - .9 Optical fiber power meter/light source test result.
 - .10 Electronics Security Systems Testing and Commissioning Results.
 - .11 Fire-stop design and records documentation
 - .12 Manufacturer's installation and operation manuals for all components, application software and any associated cables shall be left on-site with support documentation for future reference.
 - .13 Names, addresses, phone numbers and facsimile numbers of the Communications Systems Contractor, Communications Systems Contractor's RCDD, sub-Communications Systems Contractors and suppliers used on the Work together with a specification reference of the portion of the Work they undertook.

- .3 In addition to the applicable requirements in this Section, the Communications Systems Contractor will submit the following:
 - .1 Full size set of As-Built drawings
 - .2 (3) USB Memory Keys of As-Built drawings.
 - .3 PDF (all files combined into a single document).
- .4 Maintenance Manual will be in a suitably labelled, hard back, D-Ring type commercial binders, each complete with an index and tabbed title sheets for each section.
 - .1 All binder pages will have self-adhesive reinforcing rings at each binder ring.
 - .2 All maintenance manual data will be printed on 8 1/2" x 11" heavy bond, indexed, tabbed, punched and bound in the binders. Drawings will be printed on 11" x 17". Each manual will have a title sheet which is labelled "Operation & Maintenance Manual with an associated Table of Contents for each volume. If a manual exceeds 75 mm in thickness, provide additional manuals as required.
 - .3 Soft copy of the Maintenance Manual in PDF format on a separate USB Memory Key.

1.10 COMMUNICATIONS SYSTEMS CONTRACTOR QUALIFICATIONS

- .1 Certified Personnel:
 - .1 Communications Systems Contractor Communications Systems Contractor: an authorized "CommScope Uniprise Business Partner".
 - .2 All Technicians performing cable system installation work shall meet current CommScope Uniprise Training requirements, including ACT I (SP3801 Installing Premises Cabling Systems), ACT II (SP3802 Certifying and Troubleshooting Premises Cabling Systems) and ACT III (SP3000 Structured Cabling Infrastructure Design). All Technician certification cards shall be checked prior to work start up. Technicians must be current employees of the Communications Systems Contractor. No sub-contracting shall be allowed.
 - .3 The Communications Systems Contractor shall assign a Supervisor with current RCDD certification to provide Quality Control based on the "Communications Infrastructure Standards and Specifications," and to provide weekly report to the Contractor.
 - .4 The Communications Systems Contractor shall have worked satisfactorily for a minimum of five (5) years on CommScope Uniprise structured cabling solutions.
 - .5 Upon request of the Consultant, the Communications Systems Contractor will supply a list of references with specific information regarding type of project and involvement in supplying and installing equipment and systems.

1.11 COMMUNICATIONS SYSTEMS CONTRACTOR RESPONSIBILITIES

- .1 In the event that the certified system ceases to support the certified application(s), whether at the time of cutover, during normal use or when upgrading, the manufacturer and vendor will commit to promptly implement corrective action.
- .2 The Communications Systems Contractor will use qualified service personnel to conduct all work and at any time will show manufacturer's certification and/or submit references upon request of the Consultant.
- .3 The maintenance on site of one complete set of white prints to be used exclusively for purposes of recording changes, deviations and revisions from the original contract.
- .4 Scheduling the Work in a manner acceptable to the Contractor.
- .5 The Communications Systems Contractor has the responsibility to ensure that all provisions of these Standards are met and to specifically advise the Consultant in writing of any contemplated exceptions and obtain approval in writing for these changes.
- .6 The complete scope of all work is fully described in Division 27 drawings and technical specifications described herein.
- .7 The words "provide", "supply", "furnish", and "install" will imply that the Communications Systems Contractor will provide all necessary labour, materials, and equipment to complete the installation and where applicable, test same to the approval of the Consultant.
- .8 Unless otherwise noted or specified, the Communications Systems Contractor will provide all equipment and / or materials shown on the drawings and defined in the specifications.
- .9 Any apparatus, appliances, materials, or work not shown on the drawings, but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, will be furnished, delivered, and installed by the Communications Systems Contractor, without additional expense.
- .10 Establishment and verification of dimensions, elevations, grades, boundaries shown on drawings and, reporting of any errors or inconsistencies to the Consultant and or the Contractor before starting Work. Starting Work will imply that the Communications Systems Contractor has verified all items and found them to be correct. Additional costs arising out of any subsequent rectifications will be borne by the Communications Systems Contractor.
- .11 The maintenance of discipline and general orderliness of work areas throughout the duration of the Project.
- .12 Take steps to prevent dust from escaping the immediate work zone and from settling on or contaminating communications equipment and terminal hardware, as well as furniture and equipment.

1.12 COMMUNICATIONS SYSTEMS CONTRACTOR'S FOREMAN

- .1 The Communications Systems Contractor will designate a Foreman to remain on the job site from the time construction commences until final completion and acceptance of the Work
- .2 The Foreman will not be changed unless satisfactory reasons are given in writing to the Contractor.

1.13 SEQUENCE AND SCHEDULING

- .1 The Communications Systems Contractor will submit a complete Construction Schedule for the installation of equipment (if specified), and cabling.
- .2 The Construction Schedule will indicate delivery, installation, and testing dates for each component of the project. A typical project schedule submitted by the Communications Systems Contractor will provide the following key milestone dates:
 - .1 Contract Award.
 - .2 Submittal and Approval of Shop Drawings
 - .3 Key Material Procurement Dates
 - .4 Horizontal Cabling
 - .1 Cable Rough-in
 - .2 Firestopping
 - .3 Cable Termination
 - .4 Testing
 - .5 Labelling
 - .5 Backbone Cabling
 - .1 Cable Rough-in
 - .2 Firestopping
 - .3 Cable Termination
 - .4 Testing
 - .5 Labelling
 - .6 Telecommunication Grounding Backbone
 - .1 Bonding Conductor Rough-in
 - .2 Busbar Installation
 - .3 Bonding Conductor Termination
 - .4 Labelling
 - .7 Communications Room Make Ready
 - .1 Racks/Cabinets/Cable Management Installed
 - .2 Grounding and Bonding Complete
 - .3 Cable Termination Equipment Installed

- .4 Labelling
- .5 Final (Equipment Ready) Clean
- .8 Equipment Installation Dates
- .9 Submission of As-Built Documentation Package
- .10 Substantial Performance.
- .11 Communications Consultant and or the Contractor Acceptance.
- .3 The Communications Systems Contractor will ensure their schedule aligns to and is coordinated as well as the schedules of other sub-trades (electrical, mechanical, etc.), the Authority and other third parties whose tasks impact either the start and/or completion of the Communications Systems Contractor's tasks.
- .4 The Communications Systems Contractor will submit a separate demolition time schedule with applicable cut-over in areas that have existing users. This applies to any areas where systems will need to be taken off-line.

1.14 MATERIALS

- .1 Materials not approved or not conforming to the Contract Documents will be rejected
- .2 The Communications Systems Contractor will identify materials with long delivery times immediately upon submittal of shop drawings and will order such materials as soon the shop drawings are reviewed by the Consultant.
- .3 Materials will be delivered on site in original containers and packages with labels and seals intact. Use in strict accordance with manufacturer's latest printed directions and instructions unless otherwise specified.
- .4 Material deliveries to the site will be the responsibility of the Communications Systems Contractor. After delivery, the Communications Systems Contractor will take responsibility to protect material during storage and handling to prevent damage and theft. Do not store equipment or materials where conditions fall outside manufacturer's recommendations for environmental conditions. Do not install damaged material or equipment. Material or equipment damaged during installation will be replaced.

1.15 COMMUNICATIONS ROOMS – DUST CONTAINMENT AND ACCESS

- .1 Dust Containment
 - .1 ANSI/TIA-569-D Commercial Building Standard for Telecommunications Pathways and Spaces:
 - .1 To mitigate dust containment, Communications rooms (e.g. main and local communications rooms, exclude data centres which have more stringent requirements) will not be used as storage areas to store cardboard boxes, ladders and other materials as they tend to accumulate dust particles. This ensures Communications rooms are kept generally clean.
 - .2 Communications rooms will be protected from contaminants and pollutants that affect the operation and material integrity of the installed equipment and connecting hardware.

- .3 The Contractor will effectively protect the Communications rooms, equipment, connecting hardware and materials from dust, dirt and damage during construction.
- .4 Dust containment measures such as vapour barrier, positive room pressure and absolute filters will be provided.
- .5 Precautionary measures will be taken to ensure dust containment measures taken to protect equipment will not cause the equipment to overheat.
- .6 Any dust or particulates that may have resulted from the work will be mitigated from spreading by placing the nozzle of a vacuum close to the point of drilling, cutting, grinding, sanding and the like that create dust.
- .7 The work area will be cleaned up and vacuumed on a daily basis. Communications rooms, the outside of equipment racks, cabinets and panels, the inside of power panels, connecting hardware, Communications outlets and the like will be vacuumed.
- .8 Prior to receiving any network equipment from the Owner to install, the Contractor shall conduct air quality testing and provide the Consultant with a report and analysis of particle counts before and after the cleaning of TR's.
- .9 The Contractor will provide clean room sticky mats, booties, curtains and plastic strip doors and air scrubbers as required to keep the TR's clean until target Substantial Completion of the Facility is achieved.
- .2 After room turn-over, all un-authorized people must have prior approval from the Owner and be granted access before entering Communications rooms. Timing of each room turn-over to be coordinated by Contractor with the Owner.
- .3 Equipment cannot be added or removed from the racks unless specifically stated within the project's scope of work or authorized by the Contractor and the Owner. This includes power cables, network cables and fiber cables.
- .4 Failure to comply with these rules will result in the removal of access to the Communications rooms.
- .5 Network equipment and switches provided to the Contractor for the interior of the Facility will not be installed until the Facility is enclosed, weather tight, temperature and humidity conditions are approximately the same as final conditions expected, fiber backbone is installed and tested, most construction activities are completed and surfaces have been swept and treated for dust control. The Contractor will not be allowed to install wireless and wired network hardware until the Owner has inspected the interior conditions of the Facility and provided written approval to proceed with the installation.
- .6 Prior to receipt of network equipment and switches, the Contractor is required to provide the Owner with as-built documentation and the test results for the intra-building fiber backbone system. Upon receipt of

network equipment and switches, the Contractor will be financially responsible for any damage or disappearance of Owner's provided material due to improper handling and storage, negligence, fire, theft and environmental conditions during construction.

1.16 PRE-INSTALLATION SITE SURVEY

- .1 Prior to start of systems installation, the Communications Systems Contractor will meet at the project site with the Contractor and Representatives of trades performing related work to co-ordinate efforts.
- .2 The Communications Systems Contractor will review areas of potential interference and resolve conflicts before proceeding with the work. Facilitation with other trades will be necessary to meet critical deadlines for completion of Communications Rooms and Closets.
- .3 Examine areas and conditions under which the system is to be installed. Do not proceed with the work until satisfactory conditions have been achieved.

1.17 PROJECT MEETINGS

- .1 The Communications Systems Contractor's Project Manager and Foreman will attend all meetings that may be requested by the Contractor.

1.18 INSPECTIONS

- .1 The Communications Systems Contractor will request and coordinate representation from the Consultant for inspection of cabling system during, but not limited to the following stages of construction:
 - .1 Communications room construction
 - .2 Wall layout of various low voltage systems, entrance copper cables, grounding system, system panels, connecting hardware and GigaBIX mount.
 - .3 Floor layout of equipment racks and double-sided finger-type vertical cable managers on both sides of each rack.
 - .4 Ceiling layout of cable tray, and cable dropouts over side of tray (clip-on Cablofil 115mm deep) into vertical cable managers and GigaBIX mount. This is to provide unrestricted access of cables from the tray into the vertical managers, and to avoid cutting of tray at the bottom.
 - .5 Proper positioning of lighting and mechanical ducting layout in relation to ceiling tray, racks and sprinkler head.
 - .6 Layout of equipment on racks – horizontal cable manager, fiber patch panels, analog voice patch panels, horizontal cable patch panels in relation to switches, etc.
- .2 Cable rough-in, dressing and termination (workmanship).
- .3 Labelling.
- .4 Testing and documentation.
- .5 Completion and acceptance.

1.19 PROJECT CLOSEOUT

- .1 In addition to the requirements stated elsewhere in the specifications, the Communications Systems Contractor will not issue a final Deficiencies Inspection request until the following work has been completed and specified documentation forwarded to the Contractor:
 - .1 As-built record (soft copy) documentation has been provided.
 - .2 All systems have been tested and are ready for operation.
 - .3 Record of completed verification of Communications system has been provided.
 - .4 Fire-stop installation is performed as per Fire-stop Section 27 05 29.
 - .5 The clean-up is finished in all respects.
 - .6 All inspection certificates have been furnished including final low voltage and/or Electrical inspection certificate.
 - .7 As-built drawing package will confirm location and identification of all:
 - .1 Communications Outlets and jack numbers with serving Communications Room ID.
 - .2 Communications Rooms.
 - .3 Communications Room boundary lines
 - .4 Backbone Cable Runs.
 - .5 Communications Room floor and ceiling layouts (rack, GigaBIX mount, wall-mount system panels, vertical & horizontal conduit sleeves, ceiling tray, etc.).
 - .6 Fiber, Copper and Grounding schematics.

END OF SECTION

1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.1 Section 26 05 28 – Grounding and Bonding

.2 Section 27 05 00 – Common Works for Communications Systems

.3 Section 27 05 28 – Pathways for Communications Systems

.4 Section 27 05 53 – Identification for Communications Systems

.5 Section 27 11 00 – Communication Room Fittings

1.2 REFERENCES

.1 CEC, CSA C22.1-15 “Canadian Electrical Code” Part 1

.2 ANSI/TIA J-STD-607-C standard

1.3 STATUTORY AUTHORITY – ELECTRICAL SAFETY

.1 Canadian Electrical Code, Part 1, Twenty-Third Edition.

.2 Safety Standard for Electrical Installations.

.3 Canadian Standards Association Standard C22.1-18 is adopted in whole, including any errata and with the changes set out in schedule, as the B.C. Electrical Code Regulation, is in force.

1.4 DEFINITIONS

.1 Define the following list of terms, as used in this specifications as follows:

.2 “CM”: Circular Mil.

.3 “MBRGB”: Main Building Reference Grounding Busbar.

.4 “TBB”: Telecommunications Bonding Backbone.

.5 “TBC”: Telecommunications Bonding Conductor.

.6 “PBB”: Primary Bonding Busbar.

.7 “SBB”: Secondary Bonding Busbar.

1.5 SUBMITTALS

.1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

1.6 AS-BUILT DOCUMENTATION

.1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

1.7 SYSTEM DESCRIPTION

.1 Telecommunications Grounding as described on the drawings are to be referred to as a minimum requirement using a dedicated ground.

- .2 The Telecommunications Grounding Backbone system contains grounding bus bars, ground bars conductors, and connecting devices (including but not limited to compression lugs, taps, ground bushings, clamps, or exothermic welds). These components provide a low impedance path to ground for stray voltages or spurious signals present on telecommunications media and equipment.
- .3 Grounding and bonding practices will comply with all applicable codes.

2 Products

2.1 GROUNDING & BONDING CONDUCTORS

- .1 TBB
 - .1 Conductor: Class I stranded copper.
 - .2 Insulation: Flex EPR/Hypalon LS, green in colour.
 - .3 The cable will have the insulation grade, the conductor gauge, and applicable UL jacket listings printed on the insulation.
 - .4 Where conductors with green insulation are not commercially available, provide a minimum of 100 mm long colour band with green, non-aging, plastic tape in accordance with CEC. This band will occur at both ends of the conductor, and at all connections between.
 - .5 Gauge: #4/0.
- .2 TBC:
 - .1 Bonding conductor will be green jacketed, stranded copper, soft conductor, unless otherwise noted.
 - .2 Conductor:
 - .1 Class I stranded copper.
 - .2 Insulation: Flex EPR/Hypalon LS, green in colour. The cable will have the insulation grade, the conductor gauge, and applicable UL jacket listings printed on the insulation.
 - .3 Gauge: Per the Canadian Electrical Code and as modified by the TIA standard.
 - .3 All bonding conductors will be approved as defined in CSA C22.1-15.

2.2 GROUNDING BUSBARS

- .1 PBB
 - .1 Material: Tin plated copper
 - .2 Minimum dimension of 100 mm wide X 500 mm long X 6 mm thick.
 - .3 Holes: Predrilled, with standard NEMA bolt hole sizing & spacing for this type of connectors used.
 - .4 Mounting: Utilize insulated standoffs.
 - .5 Manufacturer: Panduit GB4B0624TPI-1
- .2 SBB
 - .1 Material: Tin plated copper

- .2 Minimum dimension of 70 mm wide X 305 mm long X 6 mm thick
- .3 Holes: Predrilled, with standard NEMA bolt hole sizing & spacing for the type of connectors used.
- .4 Mounting: Utilize insulated standoffs.
- .5 Manufacturer: Panduit GB2B0306TPI-1

2.3 CONNECTORS

- .1 General: All connectors will be ULC listed.
- .2 Connectors shall be intended for the application.
- .3 Acceptable connector types include: Two Hole Compression Lug, H-Tap, C-Tap, Post Burndy, Split-bolt Burndy, Ground bushings, Pedestal Clamps.

3 Execution

3.1 GENERAL

- .1 Install a complete, permanent, and continuous bonding and grounding system for Communications infrastructure and, equipment including all necessary conductors, connectors and accessories, as indicated on drawings and this document, in order to conform to requirements of the referenced Codes and Standards.

3.2 IDENTIFICATION

- .1 Refer to Section 27 05 53 Identification for Communications Systems for labelling requirements.

3.3 GROUNDING & BONDING CONDUCTORS

- .1 Bonding conductors placed in metallic conduits longer than one metre must be bonded at each end of the conduit with the appropriate bonding bushing.
- .2 Where the Communications rooms are stacked, the bonding conductor will be a common riser bonding conductor for connection to the stacked Communications rooms.
- .3 Where practicable, all bonding conductors will be installed without a splice. Where a splice is necessary, it will be accessible and located within a Communications room. Conductors will be spliced using irreversible compression-type connectors, exothermic welding, or equivalent. All joints will be adequately supported and protected.
- .4 Bonding conductors shall be as short as possible and routed with a minimum of bends. All bends made on the conductor shall be sweeping bends. Minimum bending radius is 200 mm (8") bonding conductors will be fixed to the walls and neatly formed around the perimeter of the room.
- .5 Install a bare #6 AWG copper stranded conductor, in the entire length of surface raceway or cable tray and bond to the telecommunications grounding system.
- .6 The cable tray bonding conductor will be bonded to cable tray by a bonding clamp at each straight length of tray regardless of length and each elbow and T-fittings.
- .7 All splices of bonding conductors will be outside of the cable trays.

- .8 Conduits for individual outlets will be bonded using a #12 AWG stranded insulated copper conductor from the conduit bonding bushing to the cable tray bonding conductor.
- .9 The metallic jacket of metallic shielded & interlocking armoured backbone cables will be bonded with a #6 AWG green jacketed stranded copper conductor at the jacket opening at both ends of the cable, using a Grounding Bushing on an armoured cable connector designed for the cable being used.
- .10 Metallic cable protectors will be bonded with a #6 AWG green jacketed stranded copper bonding conductor.
- .11 Equipment racks and Communications equipment will be bonded with a #6 AWG green. Each rack will be bonded with a #6 AWG green directly to the PBB or SBB (star-wired).
- .12 Metal parts (including non-electrical equipment, i.e. duct work) in the Communications rooms will be bonded to the appropriate ground busbar.
- .13 Power panels in Communications rooms will be bonded to the PBB or SBB with ground cable sized as per the requirements of the CEC.
- .14 Bond Primary Protector.
- .15 Bond Static Dissipative Flooring.
- .16 Bond aisle containment systems.
- .17 All Communications EMT conduit and tray leaving the Communications room will be bonded.
- .18 Bond the metal frame of the building to the PBB/SBB; cable sized as per the CEC.
- .19 All Communications outlet boxes will be bonded.
- .20 Install #12 AWG insulated stranded copper bonding conductor to metal Wiremold surface raceway, and bond to the building and telecommunications grounding systems for joint- use power and Communications applications. Bond to telecommunications grounding system if the raceway is dedicated only for Communications use.
- .21 Protect exposed bonding conductors from mechanical damage.

3.4 GROUNDING BUSBARS

- .1 The PBB will be connected to the building main Electrical ground busbar with a #4/0 AWG green jacketed stranded copper conductor.
- .2 The size of the TBB is a minimum size of 4/0 AWG.
- .3 All SBB's will be connected to the PBB with a minimum #4/0 AWG green jacketed copper conductor FT rated as per the AHJ or installed in conduit.
- .4 A grounding busbar will be placed below the ceiling cable tray at 2300 mm AFF near the corner of the wall that adjoins another wall where the conduit sleeves are located. It will be mounted to the wall with insulating stand-offs.

3.5 CONNECTORS

- .1 All connections to the TBB will be accessible and located in a Communications room.
- .2 Compression Taps:
 - .1 TBB will bond the PBB with each SBB (star configuration – individual TBBs) or
 - .2 TBB will bond the PBB to the farthest SBB (riser configuration – one main TBB where SBBs between PBB and farthest SBB are tapped off).
- .3 Compression Connectors (Lugs)
 - .1 General: Compression connectors will be used as a connection device from TBCs to SBBs.
 - .2 Bonding connections will be made with star-washers, dual bolts, triple crimp connectors, clamps, or lugs specifically designed for the purpose.
 - .3 A lug will be crimped to each end of the bonding conductor. Bonding conductors will be bolted on the appropriate ground busbar with a 6 mm copper alloy bolts and nuts.
 - .4 Leave 6 spare connectors in the MER and 4 spare connectors in each TR Communications Room.
 - .5 Prior to attaching a lug to a painted or galvanized surface, the paint will be scraped off to bare metal, to provide maximum contact. Paint Piercing washers will be used with the bolts.
 - .6 Install two-hole connectors in accordance with manufacturer's instructions
 - .7 Copper lug for #6 AWG conductor, with two 6 mm bolt holes, or approved equivalent.
 - .8 Copper lug for 4/0 AWG conductor, with two 8 mm bolt holes, or approved equivalent.
- .4 Connections to Conduits
 - .1 Entrance Conduits: For connecting bonding conductor to all 103 mm rigid steel entrance conduits, use threaded insulated throat grounding bushings.
- .5 Connections to Busbar
 - .1 General: Compression connectors will be used as a connection device for TBC to SBBs.
 - .2 Standard barrel copper lug for #6 AWG conductor, with two 6 mm bolt hole.
 - .3 Standard barrel copper lug for 4/0 AWG conductor, with two 8 mm bolt holes.
 - .4 Two 8 mm lugholes, for all conductors between #4 AWG to 4/0 AWG conductors.
 - .5 Two 6 mm lugholes, for #6 AWG conductors.

- .6 Connections to Communications Racks and Cabinets.
 - .1 General: Connectors will be used as a connection device for TBC's to equipment racks. Paint will be removed from the rack location where the connector is attached to ensure metal to metal contact. Star washers will be used.
 - .2 Each rack will have a dedicated #6AWG bonding conductor homerun to the busbar. The racks will not be daisy-chained with a single bonding conductor back to the busbar.
- .7 Connections to Structural Steel
 - .1 Where shown on the Drawings, connect grounding conductors to structural steel using exothermic welds. Each particular type of weld will use a kit unique to that type of weld.
- .8 Connections to Interlocking Armoured Fiber Optic Cable
 - .1 Bond the armour of the cable at both ends of the cable with armoured flex connector's c/w grounding bushings sized to suit the cable.
 - .2 Provide a #6 AWG green insulated ground cable and bond the TMG or PBB.
- .9 Connections to Distributed Antenna System Antennae
 - .1 Ground protection provisions will be engineered into the building design and installed by the Contractor for effective roof-mounted antenna mast and support structure grounding.
 - .1 The Contractor will bond the antenna mount with a ground cable
 - .2 Conductor bonding shall be made using exothermic welding, listed irreversible high-compression fittings.
 - .2 See Division 26 Grounding Specification for more detail on grounding of this system.
- .10 Connections in Entrance Facility
 - .1 Provide a Telecommunication grounding system as per drawings.
 - .2 Provide SBB.

END OF SECTION

1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
 - .1 Section 08 31 00 – Access Doors and Frames
 - .2 Section 27 05 00 – Common Works for Communications Systems
 - .3 Section 27 05 26 – Grounding and Bonding for Communications Systems
 - .4 Section 27 05 53 – Identification for Communications Systems
 - .5 Section 27 11 00 – Communication Rooms Fitting
 - .6 Section 27 13 13 – Communications Copper Backbone Cabling
 - .7 Section 27 13 23 – Communications Fiber Backbone Cabling

1.2 DOCUMENTS

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.3 SYSTEM DESCRIPTION

- .1 The Communications Pathways consist of the following subsystems:
 - .1 Cable Tray System and various fittings – overhead (within the ceiling space) from the building entrance rooms, equipment rooms, and TRs throughout the building space.
 - .2 Conduit and fittings.
 - .3 Miscellaneous conduit fittings and products.
 - .4 Conduit sleeves, Fire Stop sleeves, Conduits
 - .5 Wall outlet boxes.
 - .6 Floor boxes.
 - .7 Pull and junction boxes.
 - .8 Access Panels
- .2 Pathway design and space assignment will be coordinated with the mechanical, electrical, plumbing, and pneumatic tube systems designs.
- .3 The work under this section will also include the planning and coordination with General Contractor (and other trades) of Communications system pathways, the furnishing of necessary materials, and the labour & associated services required to install Communications pathways.

1.4 SUBMITTALS

- .1 General: Conform to Submittal requirements as described in Section 27 05 00.

2 Products

2.1 CABLE TRAY

.1 Basket Tray

- .1 Application: Suitable for the support & management of Communications cables, either overhead or mounted vertically on a wall.
- .2 Description: Cable basket will be made of steel wires and formed into a standard 50-mm by 100-mm or 50-mm by 50-mm wire mesh pattern. Wire intersections will be welded. Wire ends along sides (flanges) will be rounded during manufacturing for safety of installers and to prevent damage to cables.
- .3 Material: Carbon steel wire, ASTM A510, Grade 1008. Wire welded, bent, and surface treated after manufacture.
- .4 CabloFil or Flextray is the approved basket tray manufacturer
- .5 Fittings: Field fabricated in accordance with manufacturer's instructions from straight sections.
- .6 Size: The minimum size tray in communication spaces is 610 mm wide x 152 mm deep unless specifically noted otherwise.
- .7 Accessories: Corner, intersection, cable drop out, and attachment bracket fittings as indicated on drawings.
- .8 Grounding: Terminal support and cable support for attachment on tray of continuous #6 AWG ground conductor fixing system.
- .9 Electro-plated zinc: Support accessories and miscellaneous hardware will be coated in accordance with ASTM B633 SC3.
- .10 Cable Label Clips: Mark and identify specific cable runs, electro-zinc plated steel.

.2 Ladder Tray

- .1 For the Corridors, provide 610 mm wide with a fill depth of 152 mm deep as shown on drawings. Use manufacturer accessory corner bracket kits for radius bends for all directional changes to the cable tray.
- .2 Legrand is the approved manufacturer.

2.2 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- .1 Per Division 26 specification.
- .2 Minimum size 27mm. Provide 2x 27mm conduits to every outlet box with more than 2x data drops.
- .3 Conduit: Will be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication.
- .4 Set Screw Steel type couplings: Electroplate steel or cast malleable iron; concrete tight, with insulated throat, using gland.
- .5 Compression type connectors: Electroplated steel or cast malleable iron, concrete tight, with insulated throat.

2.3 PVC CONDUIT AND FITTINGS

- .1 Per Division 26 specification.
- .2 Bend radius, box size, conduit fill per reference standards.

2.4 PULL BOXES

- .1 Unless otherwise specified, the minimum size of a pull box will be 610 mm x 610 mm x 305 mm deep. Refer to Section 27 05 53 for labelling requirements.

2.5 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC)

- .1 Conduit: Will be fabricated in continuous lengths from galvanized steel strips, interlocking spirally wound, covered with extruded liquid tight jacket of polyvinyl chloride (PVC). Provide conduit with a continuous copper-bonding conductor wound spirally between the convolutions.
- .2 Fittings: Connector body and gland nut will be of cadmium plated steel or cast malleable iron, with tapered, male, threaded; insulated throat and neoprene "O" ring gasket recessed into the face of the stop nut. The clamping gland will be of moulded nylon with an integral brass push-in ferrule.
- .3 Application: Suitable for an indoor installation for the support of Communications cables from a feed pathway to furniture systems or similar.

2.6 COMMUNICATIONS SYSTEM OUTLET BOXES

- .1 A Communications outlet is the point at which the Communications equipment is connected to the network. The outlet consists of an outlet box and cover plate, connecting conduit, several jacks, and its connecting cables.
- .2 Outlet boxes will be specified on drawing.
- .3 Flush-Mount Box
 - .1 Provide one-piece die formed or drawn steel, knockout type box of size and configuration as indicated on the Electrical Drawings. No sectional boxes.
 - .2 103 mm square by 103 mm deep will be minimum box size.
 - .3 Mud ring will be used on top of the electrical box to receive single gang outlet faceplate.
- .4 Surface-Mount Box
 - .1 Manufacturer:
 - .1 Wiremold
 - .1 5500 or 5500A (in-line or offset with 5500 series surface raceway).
 - .2 V5744-2 (dual-gang for use with conduits).
 - .2 Panduit
 - .1 JBP2D1W (132 mm x 132 mm x 70 mm dual-gang for use with Panduit).

2.7 COMMUNICATIONS SYSTEM OUTLET PLATES

- .1 Unless specified to the contrary, all outlet plates will be plastic or stainless steel with appropriate cut-outs and permanently marked designations, as specified in the outlet specifications of the related sections.
- .2 Plastic plates will be the same colour as determined for the power outlets. The architect's decision is final.
- .3 Ensure that total depth of raceway and outlet plate is sufficient for terminating Horizontal cable and jacks.

2.8 SURFACE RACEWAYS PRODUCTS

- .1 Refer to Division 26 specifications.

2.9 FLOOR BOXES

- .1 Refer to Section 26 05 32 Outlet Boxes.

2.10 AUDIO VISUAL (A/V) WALL BOXES

- .1 Wall Storage Box
 - .1 Provide and install large in-wall storage/junction boxes. Install them in the rooms in accordance to the electrical drawings. The backbox shall have multiple depth break away edge allowing compatibility with standard 3.5" studs & 2.5" studs and be stud mountable with knockouts for single gang outlets and 1-1/4", 1", & 1/2"conduit and Integrated universal zip tie anchor points. The box shall have a paintable flange and cover to blend in any environment and the cover shall include optional tamper proof security. Approved: Chief PAC 526 with flange and cover; or approved equal
- .2 Wall Storage / Swing Arm Box
 - .1 Provide and install large in-wall storage/junction boxes. Install them in the rooms in accordance to the electrical drawings. The backbox shall have multiple depth break away edge allowing compatibility with standard 3.5" studs & 2.5" studs and be stud mountable with knockouts for single gang outlets and 1-1/4", 1", & 1/2"conduit and Integrated universal zip tie anchor points. The box shall have mounting points to fit the Chief swing arm mounts. Approved: Chief PAC 501B with PACHFK1; or approved equal

3 Execution

3.1 GENERAL

- .1 The Contractor will supply and install a system of cable raceways consisting of a combination of cable tray and conduit. The cable trays extend horizontally from the Communications Rooms, down the hallways or corridors to become the backbone or main highway to support communications cables.
- .2 Each communications outlet will be stubbed out to the nearest corridor onto the cable tray. If the cable tray is greater than 300mm from the stub out location, non-continuous open supports (J-hooks) are permitted.
- .3 Install conduit and sleeves where required prior to pouring concrete. Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure to keep furring to a minimum.

- .4 All raceway will be installed parallel to building lines, keeping cable run length at an absolute minimum.
- .5 Where raceway size is not specified, the raceway will be sized to not exceed a 28% fill ratio after all the cables are installed.
- .6 A Mule tape will be left in all backbone raceways after installation of the cables. Mule tape will be Greenlee 4435 or approved equal for backbone conduits.
- .7 The Contractor will ensure adequate support for raceways and cables dropping vertically to equipment where there is no wall support. Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .8 Explosive drive pins will not be allowed on the works without prior approval of the Communications Consultant. All fixings to be metal expansion type in pre-drilled holes. The Contractor will not use plastic expansion inserts or fittings. The Contractor will use coach screws, lag screws or wood screws, minimum 27 mm long, in wood construction.
- .9 The Contractor will provide supports for equipment and materials supplied. The Contractor will provide all anchor bolts and other fastenings, where shown on or in tile walls or wall inadequate to support the equipment, provide angle or channel iron supports to bear the equipment, independent of the wall or conduit. All hangers, supports and brackets will be provided and installed to be consistent with the requirements of the B.C. Building Code.
- .10 The Contractor will provide seismic bracing of tray. Following installation of all equipment and fixings, the Contractors will provide a seismic restraint structural review of the fixings of all devices which form part of the Communications infrastructure installation. The Contractor will provide a structural engineer registered as a Professional Engineer in the Province of British Columbia to sign and seal the report. The Contractor will reinstall, if necessary, supports for the equipment and fixings to the satisfaction of the structural engineer, at no additional cost.
- .11 Cutting and Coring
 - .1 It is expected that tradesmen skilled in their trades will do the work of that trade. Electricians performing painting, dry-walling or carpentry work will not be accepted.
 - .2 Ensure that all penetrations through floors or walls are patched to match adjoining finish. Penetrations through concrete are to be sealed with approved fire-stop material.
 - .3 Cutting and patching are to be done to architectural standards and will be inspected by the architect. Refer to the architectural specifications.
 - .4 Refer to Fire Stop Systems Section 27 05 29.
 - .5 Carpet at core locations is to be carefully cut out with a knife to the exact diameter of the pipe prior to coring if the pipe is to be exposed. Fire-stop from below at these locations

3.2 **BACKBONE CONDUITS AND SLEEVES**

- .1 Backbone conduits and sleeves in Communications rooms will be shown on the drawings.

- .2 Ducts will protrude 100 mm above finished floor level and will be encased in concrete.
- .3 Riser ducts connecting vertically stacked Communications rooms may consist of sleeves that protrude 50 mm through the ceiling and or 100 mm through the floor.
- .4 After installation of the inter-building cables, the ducts will be closed with an approved re- enterable sealing material.
- .5 Refer to Section 3.3 for further details concerning backbone sleeve requirements.

3.3 PATHWAYS THROUGH BARRIERS

- .1 All communications cable trays that need penetrate through walls and where there is an accessible ceiling on both sides of the wall; will terminate on both sides of the wall and the following rated assembly will be installed:
 - .1 Provide a rated assembly through a gypsum wall penetration based on a HILTI Speed Sleeve Gang Plate assembly using 103 mm HILTI Speed sleeves.
 - .1 Provide 8 speed sleeves for a 610 mm cable tray.
 - .2 Provide a rated assembly through a concrete wall penetration based on a HILTI Speed Sleeve Gang Plate assembly using 103mm HILTI Speed sleeves.
 - .1 Provide 8 speed sleeves through concrete (cored holes) for a 610 mm cable tray.
 - .2 The installation of HILTI Speed sleeves in combination with HILTI Cast-in- place sleeves are acceptable provided a HILTI system drawing is provided during the shop drawing submittal phase.
- .2 For communications riser sleeves penetrating a concrete floor inside communication rooms.
 - .1 Provide a rated assembly through a concrete floor penetration based on using 103 mm HILTI Speed sleeves through HILTI Cast-in-Place sleeves.
- .3 For the installation of all other communication conduit pathways through fire rated barriers, refer to fire stop section 27 05 29.

3.4 CABLE TRAY SYSTEM

- .1 Provide cable tray in approximate location and general routing as shown on drawings.
- .2 Cable trays are usually installed in the false ceiling space of hallways and located to keep conduit lengths to a minimum. When raceway is not installed in a readily accessible false ceiling space, access hatches will be installed at a nominal spacing of 9m.
- .3 Do not route cable tray through Electrical room and Mechanical room spaces.
- .4 Cable tray may require installation of risers, bends, etc. to adjust tray up or down as well as sideways for the tray routing to fit within limits of space available, and to clear other services, ducts, pipes etc. along the route. Routing may be adjusted somewhat as necessary to enable installation of services under other trades.

- .5 Provide communication cable trays with depth and width as specified. Install 100 mm radius minimum inside bend kits and all manufacturer fittings required for a complete cable tray system. Provide an allowance for all changes in direction or elevation of the cable tray.
- .6 Do not cut the basket tray for cable exit, instead use manufacturer dropout that is designed to be attached to the tray side with the dropout hanging over the tray. Adjust the tray layout such that the dropout enables the cables to be routed directly and fully into entire cross sectional area of the vertical cable managers, GigaBIX cable management modules or false wall. Perimeter basket tray inside the Communications room will be offset at about 250 mm from the wall to the near side of the tray for attachment of tray dropouts to deliver cables into GigaBIX cable management modules and any low voltage wall-mount panels.
- .7 Sharp metal edges in cable trays which could cut the cable will be smoothed and the cable dressed away from these edges. Manufacturer surface imperfections will be touched up with a cold galvanizing coating before installing cable.
- .8 Connect the new cable tray system to the existing cable tray (if exists). Re-work existing tray ends to suit tie-in.
- .9 Cable Tray Installation
 - .1 The fill ratio for cable tray is 50% at substantial completion of the project. The remaining 50% is reserved for future growth capacity.
 - .2 Install cable system in accordance with manufacturer's instructions and recognized industry practices, and ensure that the installed system complies with requirements of the "Manufacturer's Cable Tray Installation Guidelines" pertaining to general electrical installation practices. Install cable system using splice connectors, support components, and other accessories by the same manufacturer.
 - .3 Provide supports for cable tray system at a maximum 1220 mm on centre and at both sides of each tray transition per a given route. Supports will be dual support hangers, trapeze hangers or wall brackets. Trapeze hangers will be supported by structurally approved anchoring system, and will consist of 9.5 mm (maximum size) threaded rod with appropriate hardware (nuts, washers, etc.)
 - .4 Provide materials necessary to properly support system from existing building constructions per manufacturer's instructions and meeting or exceeding recognized industry practices, and as appropriate for this project. Provide special accessories as required to protect, support and install a cable tray system.
 - .5 Interface With Other Work:
 - .1 Field verify route prior to installation.
 - .2 Coordinate the installation of the cable tray system with other trades.
 - .3 Do not support from ductwork, piping, or other equipment hangers.

- .6 Installation clearances:
 - .1 Install system a minimum of 1220 mm from any motor.
 - .2 Install system a minimum of 150 mm from fluorescent light fixtures, or other EMI sources.
 - .3 Install system to allow a minimum of 305 mm above, 600 mm in front, and 75mm below of clearance from piping, conduits, ductwork, etc.
- .7 Provide cable tray hangers between 150 mm and 305 mm above ceiling grid.
- .8 Install tray support hangers between 150 mm and 305 mm above ceiling grid.

3.5 CONDUIT

- .1 All conduits will have sweeping bends with inside radius being no less than six (6) times the internal diameter of the conduit. For conduit 50mm or larger, the bend radius will be no less than ten (10) times the internal conduit diameter. Fittings such as LB type joints are not acceptable.
- .2 Provide sweeping 90° bends for conduits where conduits are above cable trays and cables are running from the conduits to cable trays to create a water fall effect to reduce the strain on cables.
- .3 When cable trays are used, conduit will be attached to the edge of the tray with a conduit bracket designed for this purpose. If this is not possible, conduit will be stubbed within 150 mm above the tray and terminate in a bonding type bushing.
- .4 Install conduits and cables within new walls
- .5 All conduit will be fixed to or hung from building structure and will not be fixed to or hung from building services, i.e. ducts, pipes, electrical conduits, sprinkler pipes, etc. Install fastenings and supports at regular intervals as required for each type of equipment, cables and conduits, and in accordance with manufacturer's installation recommendations. Provide and correctly locate all hangers and clips for the installation of all work under this Division. They will be firmly secured to the structure.
- .6 The Contractor will use rigid conduit for penetrations through exterior masonry/concrete walls and foundations, concrete floor slabs on grade
- .7 Electrical Metallic Tubing (EMT) and Fittings
 - .1 Electrical metallic tubing (EMT): Will be used to conceal interior low voltage cables where runs are concealed above suspended ceilings, in walls, furred spaces and crawl spaces.
 - .2 Preparation:
 - .1 Locations of conduit runs will be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and will not unnecessarily cross other conduits or pipe, nor block access to mechanical or electrical equipment.

- .2 Where practical, install conduits in groups in parallel vertical or horizontal runs and at elevations that avoid unnecessary offsets.
 - .3 All conduits will be run parallel or at right angles to the centrelines of columns and beams.
 - .4 Conduits will not be placed closer than 305 mm to a flue, parallel hot water, steam line or other heat producing source or 75 mm from such lines when crossing perpendicular to the runs.
 - .5 Exposed conduit installation will not encroach into the ceiling height headroom of walkways or doorways. Where possible, install horizontal raceway runs above water and below steam piping.
 - .6 In long runs of conduit provide sufficient pull boxes inside buildings to facilitate pulling wires and cables, with spacing not to exceed 30 m. Support pull boxes from structure independent of conduit supports. Not all pull boxes are not indicated on the Drawings.
 - .7 Provide all reasonably inferred standard conduit fittings and products required to complete conduit installation to meet the intended application whether noted, indicated or specified in the Contract Documents or not.
- .3 Installation
- .1 Install conduit as indicated on Drawings and as specified herein.
 - .2 Install conduits in complete runs before pulling in cables or wires.
 - .3 Install conduit free from dents, bruises or deformations. Remove and replace any damaged conduits with new undamaged material.
 - .4 Conduits will be well protected and tightly covered during construction using metallic bushings and bushing “pennies” to seal open ends.
 - .5 Clean any conduit in which moisture or any foreign matter has collected before pulling in conductors. Paint all field-threaded joints to prevent corrosion.
 - .6 Conduit systems will be mechanically and electrically continuous throughout.
 - .7 Metallic conduit will not be in contact with other dissimilar metal pipes (i.e. plumbing).
 - .8 Make bends with standard conduit bending hand tool or machines. The use of any item not specifically designed for the bending of electrical conduit is strictly prohibited.
 - .9 A run of conduit between terminations at wire pulling points will not contain more than the equivalent of two quarter bends (180 deg. total).

- .4 Penetrations
 - .1 Cutting of holes:
 - .1 Cut holes through concrete, masonry block or brick floors and floors of structure with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Structural Engineer as required by limited working space. Obtain the approval of the Structural Engineer prior to drilling through structural sections.
 - .2 Fire stop: Where conduits pass through fire rated partitions, walls, smoke partitions or floor; install a UL classified fire stop material to provide an effective barrier against the spread of fire, smoke and gases. Completely fill and seal clearances between raceways and openings with the fire stop material. Refer to Fire Stop Systems 27 05 29.
 - .3 Waterproofing: At floor, exterior wall and roof conduit penetrations, completely seal clearances around the conduit and make watertight.
 - .4 For roof penetrations furnish and install roof flashing, counter flashing and pitch-pockets.
 - .5 Provide membrane clamps and cable sealing fittings for any conduit that horizontally penetrates the waterproof membrane. Conduits that horizontally penetrate a waterproof membrane will fall away from and below the penetration on the exterior side a minimum of two times the conduit diameter.
 - .5 Terminations and Joints
 - .1 Use raceway fittings that are of types compatible with the associated raceway and suitable for use at the location.
 - .2 Raceways will be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.
 - .3 Conduits will be securely fastened to cabinets, boxes and gutters using two locknuts and an insulating bushing or specified insulated connectors. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
 - .4 Conduit terminations exposed at weatherproof enclosures and cast outlet boxes will be made watertight using specified connectors and hubs.
 - .6 Supports
 - .1 All raceways systems will be secured to building structures using specified fasteners, clamps and hangers spaced according to the CEC.

- .2 Support single runs of conduit using one-hole pipe straps. Where run horizontally on walls in damp or wet locations, install “clamp backs” to space conduit off the surface.
- .3 Multiple conduit runs will be supported using “trapeze” hangers fabricated from specified construction channel, mounted to 9.5 mm diameter and threaded steel rods secured to building structures. Fasten conduit to construction channel with standard one-hole pipe clamps or the equivalent. Provide lateral seismic bracing for hangers.
- .4 Fasteners and supports in solid masonry and concrete:
 - .1 Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
- .5 After concrete installation:
 - .1 Steel expansion anchors not less than 6 mm bolt size and not less than 28 mm embedment.
 - .2 Power set fasteners not less than 6 mm diameter with depth of penetration not less than 75 mm.
 - .3 Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- .6 Hollow masonry: Toggle bolts are permitted. Bolts supported only by masonry block are not acceptable.
- .7 Metal structures: Use stainless steel machine screw fasteners or other devices specifically designed and approved for the application.

3.6 OUTLET BOXES

- .1 Preparation
 - .1 Locate pull boxes and junction boxes in accessible locations.
 - .2 Install outlet boxes at the locations and elevations indicated on the Drawings or specified herein. Make adjustments to locations as required by structural conditions and to suit coordination requirements of construction conditions.
- .2 Installation
 - .1 Install boxes as indicated on Drawings and as specified herein.
 - .2 Do not install outlets back-to-back in wall; and allow a minimum of 150 mm horizontal clearance between boxes.
 - .3 Change location of outlets at no extra cost or credit, provided distance does not exceed 3 m, and information is given before installation.
 - .4 Locate electrical boxes as indicated on Drawings and as required for splices, taps, wire pulling, equipment connections and Code compliance.
 - .5 Install junction or pull boxes where required to limit bends in conduit runs to not more than 180 degrees or where pulling tension achieved will exceed the maximum allowable for the cable to be installed. Note that these boxes are not indicated on the Drawings.

- .6 Leave no unused openings in any box. Install close-up plugs as required to seal openings.
- .7 Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations or located in hazardous areas.
- .8 Use conduit outlet bodies to facilitate pulling of conductors or to make changes in conduit directions only. Do not make splices in conduit outlet bodies.
- .9 Mounting height of equipment is from finished floor to centre line of equipment unless specified or indicated otherwise.
- .10 If mounting height of equipment is not specified or indicated, verify with Communications Consultant before proceeding with the installation.
- .11 Communications outlets:
 - .1 Above finished floors – match mounting height of power receptacles.
 - .2 Above counters splash backs – match mounting height of power receptacles.
- .3 Supports
 - .1 Support boxes independently of conduit system.
 - .2 Support boxes, mounted above suspended acoustical tile ceilings, directly from the structure above.

3.7 ACCESS PANEL

- .1 Install access panel per specification section 08 31 00 Access Doors and Frames.

3.8 PULL BOXES

- .1 Pull boxes installed inside accessible ceilings will be within 600 mm of T-bar ceiling grid for ease of access in future.

3.9 SURFACE RACEWAYS INSTALLATION

- .1 Install Wiremold raceway where indicated on the drawings for power and Communications outlets.
- .2 The surface raceway will parallel building lines and hug ceilings, baseboards, and corners. Raceway length will be kept to a minimum.
- .3 The surface raceway base will be mechanically fastened to walls and supporting structures. Use of double-sided tape alone is not acceptable. For non-metallic surface raceway the maximum spacing of fastener is 400 mm. The recommended fasteners are as follow:
 - .4 Masonry surface – Tapcon masonry type fastener, 6 mm dia.
 - .5 Dry wall with no stud – Toggler AF “Alligator type” anchor. AF8 or AFG6.
 - .6 Dry wall with stud – Dry wall screw.

- .7 The surface raceway will maintain its integrity when passing through a wall or supporting structure. The raceway cover will be cut 100 mm from either side of the penetration.
- .8 Surface raceway extending into the ceiling will connect to the conduit extending from the cable tray with the appropriate fitting or pull box.
- .9 When installing surface raceway, manufactured bends and fittings must be used.
- .10 Installation will be in accordance with the manufacturer's instructions.
- .11 Wire clips will be installed in two-piece surface raceway installations at 450 mm centres.
- .12 Additional wire clips will be used when the raceway is secured to a ceiling or large amounts of cables are installed.
- .13 When installing cable in surface raceway, cable fill will not exceed 28%.
- .14 Provide lockable access panels at location of all pull boxes.

END OF SECTION

1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
 - .1 Section 27 05 00 – Common Works for Communications Systems
 - .2 Section 27 05 28 – Pathways for Communications Systems
 - .3 Section 27 11 00 – Communication Rooms Fitting

1.2 SUBMITTALS

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.
- .2 The Contractor will submit to Consultant for approval, the following items relating to the fire-stop system:
 - .1 HILTI Speed Sleeve manufacturer, or approved alternative, technical data for each product intended to be used on site including product description, specifications and storage requirements.
- .3 Firestop design documentation will include a schedule indicating:
 - .1 Listed firestop system tested to ULC-S115.
 - .2 Number of firestop locations.
 - .3 Type of penetration.
 - .4 Type of building construction at point of penetration.
 - .5 Hourly fire-rating of floors and walls.
 - .6 Firestop device or system proposed.
 - .7 Installation Procedures and Material Safety Data Sheets will be included with products delivered to the job site.
 - .8 Maintenance manuals and maintenance data that may be published by Manufacturer.

1.3 AS-BUILT DOCUMENTATION

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

1.4 REFERENCES

- .1 CAN/ULC-S115-11, Standard Method of Fire Tests of Through Penetration Fire Stops.
- .2 CAN/ULC-S102-M, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .3 ASTM E814, Standard Method of Fire Tests of Through-Penetration Fire Stops.
- .4 UL 1479, Fire Tests of Through-Penetration Firestops.
- .5 UL Fire Resistance Directory: Through Penetration Firestop Devices (XHCR) and Through Penetration Firestop Systems (XNEZ).

- .6 ASTM E119, Fire Tests of Building Construction and Materials (for fire-rated architectural barriers).
- .7 ASTM G-21, Standard Test for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .8 BICSI - Current Edition, Telecommunications Distribution Methods Manual (TDMM), Chapter 11, Firestopping
- .9 Factory Mutual Approval Guide.
- .10 ULC List of Equipment and Materials, VOL. II.
- .11 Current Canadian Electrical Code
- .12 Current Building Code
- .13 Installed fire stopping systems will meet approval of Local Authorities having jurisdiction.

1.5 **QUALITY ASSURANCE**

- .1 A manufacturer's direct representative (account manager, fire protection specialist, not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- .2 For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's firestop custom detail derived from similar UL system designs or other tests will be submitted to the Owner for their review and approval prior to installation. Firestop custom detail drawings must follow requirements set forth by the International Firestop Council.
- .3 Manufacturer's fire protection specialist to provide site walk-through report detailing visual review of a random sampling of applications.

1.6 **TRAINING**

- .1 The Contractor must receive training through the Firestop University program offered from HILTI, or approved alternative, and possess current certification prior to installing firestop products.

2 **Products**

2.1 **GENERAL**

- .1 Penetrations in Fire Resistance Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 - .1 F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.
- .2 Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 - .1 F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 - .2 T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.

- .3 W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.
- .3 Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 - .1 L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.
- .4 Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of 0 as determined by ASTM G21.2

2.2 SPECIFIC REQUIREMENT

- .1 For communications rooms, provide the Hilti CP-653-4" speed sleeves in the walls. For riser sleeves, use a combination of Hilti CP 680 cast-in-place firestop devices c/w CP- 653- 4" speed sleeves inserted into them. Refer to the Hilti Systems drawing.
- .2 Refer to Hilti FL3060 system drawing and C-STD-033.3 Cast-in place/Speed sleeve fire stop drawing.
- .3 Use the Hilti ganging wall plate when installing 2 or more Hilti Speed sleeves.

2.3 ACCEPTABLE MANUFACTURERS

- .1 Subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:
 - .1 Hilti, Inc., Tulsa, Oklahoma 800-879-8000 www.us.hilti.com
 - .2 Provide products from the above acceptable manufacturer; only reviewed and approved alternates can be used as substitutions.

2.4 MATERIALS

- .1 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- .2 Use only firestop products that have been UL 1479 or ASTM E 814 tested for specific fire- rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
- .3 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating gypsum or masonry walls, the following products are acceptable:
 - .1 Hilti Speed Sleeve (CP 653) with integrated smoke seal fabric membrane.
 - .2 Hilti Firestop Sleeve (CFS-SL SK)
 - .3 Hilti Retrofit Sleeve (CFS-SL RK) for use with existing cable bundles.
 - .4 Hilti Cable Collar (CFS-CC)
 - .5 Hilti Gang plate (CFS-SL GP) for use with multiple cable management devices.

- .6 Hilti Gang plate Cap (CFS-SL GP CAP) for use at blank openings in gang plate for future penetrations
- .4 Pre-formed, round firestop devices with integrated intumescent strips for use with non-combustible and combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors and/or gypsum walls, the following products are acceptable:
 - .1 Hilti Cast-In Place Firestop Device (CP 680-P) for use with combustible penetrants.
 - .2 Hilti Cast-In Place Firestop Device (CP 680-M) for use with non-combustible penetrants.
 - .3 Hilti Speed Sleeve (CP 653) for use with cable penetrations.
 - .4 Hilti Firestop Drop-In Device (CFS-DID) for use with non-combustible and combustible penetrants.
- .5 Sealants, foams or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
 - .1 Hilti Intumescent Firestop Sealant (FS-ONE)
 - .2 Hilti Fire Foam (CP 620)
 - .3 Hilti Flexible Firestop Sealant (CP 606)
 - .4 Hilti Elastomeric Firestop Sealant (CFS-S SIL GG)
- .6 Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles, and plastic pipe, the following products are acceptable:
 - .1 Hilti Intumescent Firestop Sealant (FS-ONE)
- .7 Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles, the following products are acceptable:
 - .1 Hilti Intumescent Firestop Sealant (FS-ONE)
 - .2 Hilti Fire Foam (CP 620)
 - .3 Hilti Flexible Firestop Sealant (CP 606)
 - .4 Hilti Elastomeric Firestop Sealant (CFS-S SIL GG)
- .8 Non-curing, re-penetrable intumescent putty or foam materials for use with flexible cable or cable bundles, the following products are acceptable:
 - .1 Hilti Firestop Putty Stick (CP 618)
 - .2 Hilti Firestop Plug (CFS-PL)
- .9 Wall opening protective materials for use with U.L. listed metallic and specified non-metallic outlet boxes, the following products are acceptable:
 - .1 Hilti Firestop Putty Pad (CFS-P PA)
 - .2 Hilti Firestop Box Insert

- .10 Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
 - .1 Hilti Firestop Mortar (CP 637)
 - .2 Hilti Firestop Block (CFS-BL)
 - .3 Hilti Fire Foam (CP 620)
 - .4 Hilti Firestop Board (CP 675T)
- .11 Non-curing, re-penetrable materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
 - .1 Hilti Firestop Block (CFS-BL)
 - .2 Hilti Firestop Board (CP 675T)
- .12 For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:
 - .1 Hilti Firestop Block (CFS-BL)
 - .2 Hilti Firestop Plug (CFS-PL)
- .13 The Contractor will use firestop materials that have no irritating or objectionable odours, when firestopping occupied areas of existing buildings.
- .14 Firestop products used in cross-sectional areas of pathway such as inside sleeves, or cable tray penetrations of fire barriers will be of re-enterable and reusable type to enable future Moves, Additions, or Changes.

3 Execution

3.1 COORDINATION

- .1 Firestop systems installed by the Contractor will meet the requirements of all applicable codes and ULC standards.
- .2 The Contractor will firestop new Communication pathway and/or cable penetrations of building fire barriers with an approved firestop system, following cable installation.
- .3 The Contractor will firestop with an approved firestop system, any holes created by the Work of this Contract.
- .4 The Contractor will coordinate all Work with Division 26 and the site's Facilities Maintenance and Operations department.
- .5 The Contractor will obtain inspection approval from local Authority Having Jurisdiction (AHJ) and the site's Facilities Maintenance and Operations department and will be responsible for all associated costs.
- .6 The Contractor will provide equipment, materials, labour, and services not specifically mentioned or shown which may be necessary to complete or perfect all parts of this installation and in compliance with requirements stated or reasonably inferred by the Contract Documents

3.2 INSTALLATION

- .1 The Contractor will select appropriate firestop assembly to suit the type of penetration and base the selection on criteria specified herein.
- .2 Selected firestop systems will not be less than the hourly fire-ratings indicated in the Contract Documents for each respective penetration through fire-rated floor, wall, or other partition of building construction.
- .3 Firestop for each type of penetration will conform to manufacturer's firestop design drawings or approved modifications and meet requirements of an independent testing laboratory.
- .4 The Contractor will perform all necessary coordination with trades constructing floors, walls, or other partitions with respect to size and shape of each opening, device, or firestop system approved for use in each instance. Also, the Contractor will resolve any feasibility or obstruction issues.
- .5 In areas accessible to public and other "finished" areas, the Contractor will prepare the surface area surrounding firestop penetrations to match finished quality of adjoining surfaces.
- .6 The Contractor will provide damming materials, plates, wires, restricting collars, and devices necessary for proper installation of a firestop system.
- .7 The Contractor will remove combustible installation aids after firestopping material has cured.
- .8 All Firestop assemblies will be installed in accordance with the manufacturer instructions in order to maintain the specific rating assigned by the independent testing laboratory.
- .9 The Contractor will remove excess materials and debris and clean adjacent surfaces immediately after application.

3.3 EXISTING PENETRATIONS

- .1 In existing buildings, the Contractor will firestop any gaps or cavities between penetrating cable tray, ducts, or sleeves and surrounding surface area.
- .2 The Contractor will firestop with an approved firestop system, the following existing penetrations of building fire barriers:
 - .1 Existing Communication pathway, cables, or holes that are not firestopped and are within 1 m (3') of new Communication pathway, or cable penetrations of fire barriers.
 - .2 Existing Communication cables abandoned by the Work of this Contract.
- .3 Firestop assemblies consisting of wrap around individual steel collar sections complete with intumescent putty material that completely surround penetrations, will be used for non- metallic pipes.

3.4 MASONRY POINTING PATTERN

- .1 Where firestop systems penetrate masonry barriers, the Contractor will make good surrounding area by replicating original pointing pattern and matching in quality of workmanship.

3.5 INSPECTING AUTHORITIES

- .1 The Contractor will remove and expose firestop systems to the extent directed by Inspecting Authority for the purpose of carrying out the inspection.
- .2 The Contractor will re-install firestop system and restore any affected building components removed for inspection, at no cost design.

END OF SECTION

1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.1 Section 27 05 00 – Common Works for Communications Systems

.2 Section 27 05 28 – Pathways for Communications Systems

.3 Section 27 11 00 – Communication Room Fittings

.4 Section 27 11 30 – Campus Communications Hub Fittings

.5 Section 27 13 13 – Communications Copper Backbone Cabling

.6 Section 27 13 23 – Communications Fiber Backbone Cabling

.7 Section 27 21 33 – Data Communications Wireless Access Points

.8 Section 27 51 23 – Intercom System

.9 Section 27 53 19 – Distributed Antenna System

1.2 SUBMITTALS

.1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

.2 Submit shop drawings for:

.1 Samples of methods of labelling and materials.

.2 Sample database sheet for cable identification.

2 Products

2.1 LABELS

.1 Labels for GigaBIX termination hardware.

.1 Labels are supplied in sheets:

.1 White LAN, PBX, Multiplexer

.2 Green label Entry connect

.3 Blue label Horizontal

.4 Purple label 1st level Backbone

.5 Grey label 2nd level Backbone

.6 Brown label Inter-building

.2 Substitutes are not accepted

.2 Colour scheme for jacks inserts in patch panel is black.

.3 Colour scheme for jack inserts in faceplates is alpine white.

.4 Colour scheme for faceplates:

.1 Match colour of electrical faceplate

.2 In cases where a data outlet is not installed beside an electrical faceplate, colour shall be alpine white.

- .5 Cable label for indoor cable and indoor/outdoor Interlocking armoured type fiber optic cables,
 - .1 Label type for cable labels: Labels will be pre-cut for quick and easy application.
 - .2 Labels will be in self-adhesive polyester or non-adhesive polyester (depending on label type).
 - .3 Product: Panduit S050X-xxx-VAC or approved equal.
- .6 Fiber Optic Cable label for marking cables inside outdoor pull-pits and manholes.
 - .1 Self-Laminating Rigid Vinyl equal to Panduit PST-FO or approved equal.
 - .2 Labels shall include the cable ID and the text "BCIT FIBRE"

3 Execution

3.1 INSTALLATION

- .1 Unless specified otherwise, designation labels on outlet plates will be machine-printed on tape and inserted in the top label windows of faceplates, as detailed in these and related specifications. Alternate methods must be submitted to the Communications Consultant for approval. Lamacoid labels will not be accepted.
- .2 After terminating and identifying a Communications cable, each cable will be identified with a unique cable number, as detailed in these and related specifications. The Contractor will populate cable information without any modification to a cable database and provide database file in .xlsx and .pdf formats.
- .3 All backbone fiber optic cables after exiting conduits will be labelled at each end as well as within 1 meter of each side of a wall or floor slab the cable passes through. Identify destination and originating Communications room number on each wrap around cable label, as detailed in these and related specifications.
- .4 Labelling will conform to standard faceplate detail on the drawings.
- .5 Label strips or equal will be approved by the Consultant. The Communications Contractor will label each outlet with 9 mm high black on white mechanical label.
- .6 Unless specified otherwise, all labels will be machine-printed. Brother "P-touch" electronic labelling system, or approved equal by the Consultant. Hand-lettered labels will not be accepted.
- .7 Distribution terminals will use standard TIA colour coding on all terminations as follows:
 - .1 Green = Termination of network connection on the customer side of the demarcation point.
 - .2 White/Silver = Termination of cables originating from common equipment (PBXs, computers, LANs and multiplexers).
 - .3 Brown = Inter-building Backbone.
 - .4 Purple = First-level Backbone. Riser/Backbone and between Communications rooms.
 - .5 Blue = Stations served directly from closets, i.e. horizontal wiring.

- .6 Grey = Second-level Backbone.
- .8 Faceplate Work Area
 - .1 Faceplates will have the following labels:
 - .1 Alpha-numeric ID of Communications room at top of faceplate followed by the rack number e.g. CM2003-R1
 - .2 Jack ID directly above jack shall indicate the patch panel number followed by the port number e.g. P01-24
- .9 Patch Cable and Icon Colours
 - .1 Jacket colour for all Copper patch cables shall be Black.
- .10 Communications Racks
 - .1 Communications racks will be labelled at the top middle of the rack frame on the front as R1. The second rack will be labelled as R2 and so on towards the inside of the room.
 - .2 The numbers and not the background will be 50 mm high x 40 mm wide engraved on lamacoid in permanent White on Black background.
- .11 UTP Horizontal Cable
 - .1 Communications horizontal cables will be identified at each termination end with a unique number at the faceplate (outlet jack), at the patch panel and on both ends of the cable jacket, e.g. CM2003-R1-P01-01
 - .1 CM2003 Represents Communications Room [Architectural Room Number]
 - .2 R1 Represents Rack #1.
 - .3 P01 Represents Panel #1.
 - .4 01 Represents Port #1.
- .12 Backbone Fibre Cabling
 - .1 Provide a cable label at each end as well as within 1 m of both sides of any wall and floor penetrations. Use wrap around labels inside a building. Label can be arranged in two line with the following format, e.g. 48 strands OS2 SM from NW04-1003 to NW04-3003
 - .1 48 strands Represents strand count
 - .2 OS2 SM Represents type
 - .3 NW04 Represents originating building number
 - .4 1003 Represents originating room number
 - .5 NW04 Represents destination building number
 - .6 3003 Represents destination room number
 - .2 Size of font is to be as maximum as possible, depending on the diameter of the cable.

- .13 Backbone Copper Cabling
 - .1 The first GigaBIX mount on the lower half of the GigaBIX frame will be reserved for Entrance cables.
 - .2 Backbone Copper cable will be identified at both ends. Example:
RM1003/RM3003
 - .1 RM1003 Represents origin room number
 - .2 RM3003 Represents destination room number
 - .3 Backbone Copper cables from the GigaBIX mount to the racks (CAT5e) will be terminated on 24-port patch panels that are labelled as VP1, VP2, etc. in the rack. On the GigaBIX frame, mounts will appear sequentially starting at the top frame.
 - .4 GigaBIX designation strips will identify the origin, destination and pair counts.
- .14 Fibre Patch Panel Label
 - .1 Add Alpha Numeric ID on each patch panel. First patch panel starts with “FP1”, then “FP2” and so on sequentially for each rack. Restart counter for adjacent rack.
 - .2 Size of font is to be as maximum as possible.
- .15 Copper Patch Panel Label
 - .1 Add Alpha Numeric ID on each patch panel. First patch panel starts with “P1”, then “P2” and so on sequentially for each rack. Restart counter for adjacent rack.
 - .2 Port ID directly above port shall indicate the room number on the first line and the mounting surface on the second line. E.g. Rm 3001 FLR
 - .3 Use the following abbreviations for the second line (mounting surface) on the port ID:
 - .1 N Represents North wall
 - .2 E Represents East wall
 - .3 S Represents South wall
 - .4 W Represents West wall
 - .5 FLR Represents floor box
 - .6 C Represents Ceiling space
- .16 Telecommunications Ground
 - .1 Bonding conductors will be identified on both ends of the conductors, with data plate cable marker completed with double straps, to indicate where the destination end of the conductor is located.
 - .2 Telecommunications Bonding Backbone (TBB) Label example:
 - .1 CM1003-PBB/CM2003-SBB

- .3 Bonding Conductor from Busbar to and Object Example
 - .1 CM1003-PBB/Object e.g. building steel, cable trays, etc. at both ends prior to conductor routed into its termination.
- .4 Label TBB every 6 m and within 1 m of both sides of any wall and floor penetrations with the description: “Communications Ground Only” The lettering size is 6 mm white on green background.
- .5 Examples of Telecommunications Ground Bar Labelling PBB Busbar Label
 - .1 CM1003-PBB
 - .2 CM2003-SBB
- .17 Communications Pull Boxes and Junction Boxes
 - .1 Identify all pull boxes and junction boxes using spray paint on the cover. Neatly identify the relevant system and circuit ID using permanent marker pen. Utilize green for communications colour bands.
- .18 Wireless Access Points (WAPs)
 - .1 Provide a label for each WAP with the cable ID. e.g. CM2003-R1-P01-01/02
 - .1 CM2003 Represents Communications Room [Architectural Room Number]
 - .2 R1 Represents Rack #1.
 - .3 P01 Represents Panel #1.
 - .4 01/02 Represents Ports #1 and #2.
 - .2 Contractor shall supply a WAPs schedule indicating the location (room name and number), MAC address, serial number and data drop number for each owner-supplied, contractor-installed WAP.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
 - .1 Section 27 05 00 – Common Works for Communications Systems
 - .2 Section 27 11 00 – Communication Room Fittings
 - .3 Section 27 53 19 –Distribution Antenna Systems
 - .4 Section 28 23 00 – Video Surveillance System

1.2 OVERVIEW

- .1 Test equipment will be approved by the Consultant in writing before it can be used to test the structured cabling systems.
- .2 Final details of all test parameters, scope, and methodology to be performed by the Contractor, as described in this section, will be verified with the Consultant.
- .3 All terminations will be completed and all Communications equipment installed before the tests are performed.
- .4 The installation will be tested in the presence of the Consultant when requested by the Consultant.

1.3 TESTING

- .1 Correct improper splices and replace damaged cables or connectors at no cost to the Owner.
- .2 Optical Loss Testing – Contractor shall set up their Fluke OLTS in custom settings with the maximum loss parameters identified in these specifications for MP, LC and Fiber cable. Tester Pass or Fail results shall be based on the Project Specifications for maximum dB loss which is 0.50 dB per mated pair of connectors, not the Industry Standards of maximum 0.75 dB loss for mated pairs.

1.4 TEST RESULTS DOCUMENTATION

- .1 Test results saved within the field-test instrument will be transferred into a Windows™- based database utility that allows for the maintenance, inspection and archiving of the test records. These test records will be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”. For the purposes of review only, the contractor will transfer field test results into a spreadsheet. The connector loss at both ends of the fiber link along with the fiber strand loss will be used by the Communications Consultant to determine pass or fail. The OTDR test results will be used to determine whether each connector of a fiber link is within the maximum of 0.5 dB loss level.
- .2 The database for the complete project, including twisted-pair copper cabling links will be delivered prior to Consultant acceptance of the results. The Communications Contractor will upload the software tools required to view, inspect, and print any selection of the test reports.
- .3 Circuit IDs reported by the test instrument will match the specified label ID.
- .4 The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and will contain the following information:

- .1 The identification of the customer site as specified by the end-user.
- .2 The name of the test limit selected to execute the stored test results.
- .3 The name of the personnel performing the test.
- .4 The date and time the test results were saved in the tester's memory.
- .5 The manufacturer, model and serial number of the field-test instrument.
- .6 The version of the test software and the version of the test limit database held within the test instrument.
- .7 The fiber identification number.
- .8 The length for each optical fiber.
- .9 Optionally the index of refraction used for length calculation when using a length capable OLTS.
- .10 Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
- .11 Test results to include OTDR link and channel traces, tables at the appropriate wavelength(s).
- .12 The length for each optical fiber as calculated by the OTDR.
- .13 The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements.

1.5 WORK INCLUDED

- .1 Provide all labour, materials, tools; field-test instruments and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.
- .2 In order to conform to the overall project event schedule, the Communications Contractor will monitor work progress and coordinate cable testing with other applicable trades.
- .3 In addition to the tests detailed in this document, the Communications Contractor will notify the Consultant of any additional tests that are deemed necessary to guarantee a fully functional system. The Communications Contractor will carry out and record any additional test results at no additional charge.

1.6 FIBER QUALITY ASSURANCE

- .1 All testing procedures and field-test instruments will comply with applicable requirements of:
 - .1 ANSI Z136.2, (2012 Edition) ANS for Safe Use of Optical Fiber Communications Systems Utilizing Laser Diode and LED Sources.
 - .2 TIA-455-78 Measurement Methods and Test Procedures - Attenuation
 - .3 TIA-455-78 Measurement Methods and Test Procedures - Attenuation
 - .4 TIA-455-133-A Measurement Methods and Test Procedures – Length Measurement
 - .5 TIA-455-78 Measurement Methods and Test Procedures - Attenuation

- .6 ANSI/TIA-526-7A, Optical Power Loss Measurements of Installed Single-mode Fiber Cable Plant.
- .7 ANSI/TIA-526-14C, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
- .8 ANSI/TIA-568.1-D, Commercial Building Telecommunications Cabling Standard, Part 1, General Requirements.
- .9 ANSI/TIA-568.3-D, Optical Fiber Cabling Components Standard.
- .10 ANSI/TIA-606C, Administration Standard for Commercial Telecommunications Infrastructure, including labelling requirements.
- .2 Trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof will be allowed to execute the tests. These must be issued by any of the following organizations or an equivalent organization:
 - .1 Manufacturer of the Fiber optic cable and/or the Fiber optic connectors.
 - .2 Manufacturer of the test equipment used for the field certification.
 - .3 BICSI and its authorized training partners.
- .3 The Consultant shall be invited to witness and/or review field-testing.
 - .1 The Communications Consultant will be notified of the start date of the testing phase five (5) business days before testing commences.
 - .2 The Communications Consultant may select a random sample of up to 5% of the installed links. The Consultant will witness the testing of these randomly selected links and the results are to be stored in accordance with this document. The results obtained will be compared to the original data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the Consultant will repeat 100% testing at no cost to the Owner.

Part 2 Products

2.1 OPTICAL FIBER CABLE TESTERS

- .1 The field-test instrument will be within the calibration period as minimum of 12 months or as recommended by the manufacturer. Contractor shall provide proof of the last date the equipment was calibrated.
- .2 Optical loss test set (OLTS).
 - .1 Singlemode optical fiber light source
 - .1 Provide dual laser light sources with central wavelengths of 1310 nm (+/-20 nm) and 1550 nm (+/-20 nm).
 - .2 Output power of -10 dBm minimum.
 - .3 Acceptable manufacturers
 - .1 Fluke Networks.

- .2 Power Meter
 - .1 Provide 850 nm, 1300/1310 nm, and 1550 nm wavelength test capability.
 - .2 Power measurement uncertainty of +/- 0.25 dB.
 - .3 Store reference power measurement.
 - .4 Save at least 100 results in internal memory.
 - .5 PC interface (serial or USB).
 - .6 Acceptable manufacturers
 - .1 Fluke Networks.

2.2 OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)

- .1 Singlemode OTDR
 - .1 Wavelengths of 1310 nm (+/- 25 nm) and 1550 nm (+/- 30 nm).
 - .2 Event dead zones of 0.6 m maximum at 1310 nm and 1550 nm.
 - .3 Attenuation dead zones of 4 m typical at 1310 nm and 1550 nm.
 - .4 Distance range not less than 130 km at 1550 nm and 80 km at 1310 nm.
 - .5 Dynamic range 30 dB typical at 1310 nm and 1550 nm.
 - .6 Acceptable manufacturers
 - .1 Fluke Networks.
- .2 Fiber Microscope
 - .1 Magnification of 200X or 400X for end-face inspection
 - .2 Acceptable manufacturers
 - .1 Fluke Networks.

Part 3 Execution

3.1 FIBER TESTING SCOPE

- .1 Initially test every fiber strand within the Fiber optic cable with a light source and power- meter utilizing procedures as stated in ANSI/TIA -526-14-C, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant, and ANSI/TIA-526-7 (currently Standard Proposal Number 2974-B): OFSTP-7 Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant. Measured results will be within manufacturers' cable and specified loss budget calculations. If loss figures are outside this range, test cable again with Optical Time Domain Reflectometer (OTDR) to determine cause of variation. Correct improper splices and replace damaged cables or connectors at no cost.
 - .1 This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fiber end faces will also be verified.
- .2 Testing will be performed on each cabling link (connector to connector).

- .3 Testing will be performed on each cabling channel (equipment to equipment) that is identified by the Consultant where required.
- .4 Testing will not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- .5 All tests will be documented including OLTS dual wavelength attenuation measurements for multimode and singlemode links and channels and OTDR traces and tables for multimode and singlemode links and channels.
- .6 Field-test instruments will have the latest software and firmware installed.
- .7 Link and channel test results from the OLTS and OTDR will be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative (reports) may be generated.
- .8 Fiber end faces will be inspected at 250X or 400 X magnifications. 250X magnification will be used for inspecting multimode and single-mode fibers. 400X magnification will be used for detailed examination of single-mode fibers. Scratched, pitted or dirty connectors will be diagnosed and replaced at no cost to the Owner.
- .9 It is mandatory that the end face images be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.
- .10 Testing of the cabling will be performed using high-quality test cords of the same Fiber type as the cabling under test. The test cords for OLTS testing will be between 1 m and 5 m length. The test cords for OTDR testing will be approximately 100 m for the launch cable and at least 25 m for the receive cable.
- .11 All tests performed on optical fiber cabling that use a laser or LED in a test set will be carried out with safety precautions in accordance with ANSI Z136.2.
- .12 All outlets, cables, patch panels and associated components will be fully assembled and labelled prior to field-testing. Any testing performed on incomplete systems will be redone on completion of the work. The following test parameters will be adhered to:
 - .1 Testing procedures will utilize “Method B” – one jumper reference.
 - .2 Bi-directional testing of optical Fibers is required.
 - .3 Test every strand of fiber with an OTDR.
 - .4 Fiber links will be tested with test equipment based on laser light sources categorized by a Coupled Power Ratio (CPR) of Category 2, under filled, as per IEC 60825-2.
 - .5 This rule will be followed to support Gigabit Ethernet applications. Gigabit Ethernet only specifies laser light sources and not LED (light emitting diode) light sources. Field test equipment based on LED light sources is a Category 1 device as per IEC 60825-2 and typically yields high attenuation results.
 - .6
- .13 Single-mode fiber optic cables will be tested at 1310 nm and 1550 nm.

- .7 For Gigabit Ethernet compliant certification (IEEE std 802.3z application), use Test equipment which uses a VCSEL (Vertical Cavity Surface Emitting Laser) at 850 nm (compliant with 1000BASE-SX) and an FP laser at 1310 nm (compliant with 1000BASELX).

3.2 ACCEPTANCE OF FIBER TEST RESULTS

- .1 Unless otherwise specified by the Consultant, each cabling link will be in compliance with the following test limits:
 - .1 Optical loss testing
 - .1 Multimode and Singlemode links
 - .1 The link attenuation will be calculated by the following formulas as specified in ANSI/TIA-568-C.0.
 - .1 $\text{Link Attenuation (dB)} = \text{Cable_Attn (dB)} + \text{Connector_Attn (dB)} + \text{Splice_Attn (dB)}$
 - .2 $\text{Cable_Attn (dB)} = \text{Attenuation_Coefficient (dB/km)} * \text{Length (Km)}$
 - .3 $\text{Connector_Attn (dB)} = \text{number_of_connector_pairs} * \text{connector_loss (dB)}$
 - .4 Maximum allowable connector loss = 0.50 dB
 - .5 $\text{Splice_Attn (dB)} = \text{number_of_splices} * \text{splice_loss (dB)}$
 - .6 Maximum allowable splice_loss = 0.3 dB
 - .7 The values for the Attenuation_Coefficient (dB/km) are listed in the table below:
 - .2 OTDR testing
 - .1 Reflective events (connections) will not exceed 0.5 dB.
 - .2 Non-reflective events (splices) will not exceed 0.1 dB. A maximum of 10% of all splices in the project can have an allowable splice loss of 0.3 dB.
 - .3 Fiber links will be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
 - .4 Singlemode: 1310 nm and 1550 nm
 - .5 Each fiber link and channel will be tested in both directions.
 - .6 A launch cord will be installed between the OTDR and the first link connection.
 - .7 A tail cord will be installed after the last link connection
 - .3 Magnified end-face inspection
 - .1 Fiber connections will be visually inspected for end-face quality.
 - .2 Scratched, pitted or dirty connectors will be diagnosed and corrected.

- .4 All installed cabling links and channels will be field-tested and pass the test requirements and analysis. Any link or channel that fails these requirements will be diagnosed and corrected. Any corrective action that must take place will be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels will be provided in the test results documentation.
- .5 Acceptance of the test results will be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Consultant.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
 - .1 Section 27 05 00 – Common Works for Communications Systems
 - .2 Section 27 11 00 – Communication Room Fittings
 - .3 Section 27 15 00 – Horizontal Cabling

1.2 WORK INCLUDED

- .1 Provide all labour, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of a Horizontal Category 6A cabling system.
- .2 The Communications Contractor will survey the work areas and coordinate cabling testing with other applicable trades.
- .3 In addition to the tests detailed in this document, the contractor will notify the Consultant of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor will carry out and record any additional measurement results at no additional charge.

1.3 SCOPE

- .1 This Section includes the minimum requirements for the test certification of horizontal Category 6A balanced twisted pair cabling.
- .2 This Section includes minimum requirements for:
 - .1 Copper cabling test instruments
 - .2 Copper cabling testing
 - .3 Administration
 - .1 Test results documentation
 - .2 As-built drawings
- .3 Testing will be carried out in accordance with this document.
- .4 Testing will be performed on each cabling link. (100% testing)
- .5 All tests will be documented.

1.4 QUALITY ASSURANCE

- .1 All testing procedures and field-test instruments will comply with applicable requirements of:
 - .1 ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - .2 ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
 - .3 ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard

- .4 ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
- .5 ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the Owner.
- .2 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof will execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
 - .1 Manufacturer of the connectors or cable.
 - .2 Manufacturer of the test equipment used for the field certification.
 - .3 Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas).
- .3 The Consultant will be invited to witness and/or review field-testing.
 - .1 The Communications Consultant will be notified of the start date of the testing phase five (5) business days before testing commences.
 - .2 The Communications Consultant may select a random sample of up to 5% of the installed links. The Communications Consultant will witness the testing of these randomly selected links and the results are to be stored in accordance with Part 3 of this document. The results obtained will be compared to the original data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the Communications Consultant will repeat 100% testing at no cost to the Owner.

1.5 ACCEPTANCE OF TEST RESULTS

- .1 Unless otherwise specified by the Owner or the Owners representative, each Category 6A cabling link will be in tested for:
 - .1 Wire Map
 - .2 Length
 - .3 Propagation Delay
 - .4 Delay Skew
 - .5 DC Loop Resistance – recorded for information only
 - .6 DC Resistance Unbalance – recorded for information only
 - .7 Insertion Loss
 - .8 NEXT (Near-End Crosstalk)
 - .9 PS NEXT (Power Sum Near-End Crosstalk)
 - .10 ACR-N (Attenuation to Crosstalk Ratio Near-End) – recorded for information only

- .11 PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) – recorded for information only
- .12 ACR-F (Attenuation to Crosstalk Ratio Far-End)
- .13 PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
- .14 Return Loss
- .15 TCL (Transverse Conversion Loss) – recorded for information only
- .16 ELTCTL (Equal Level Transverse Conversion Transfer Loss) – recorded for information only
- .17 PS ANEXT (Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
- .18 Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
- .19 PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2
- .20 Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2
- .2 All installed cabling Permanent Links will be field-tested and pass the test requirements and analysis as described in Part 3. Any Permanent Link that fails these requirements will be diagnosed and corrected. Any corrective action that must take place will be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links will be provided in the test results documentation in accordance with Part 3.
- .3 Acceptance of the test results will be given in writing after the project is fully completed and tested to the satisfaction of the Consultant.

Part 2 Products

2.1 PRODUCTS

- .1 Balanced twisted-pair Cable Testers
 - .1 The field-test instrument will be within the calibration as minimum of 12 month period or as recommended by the manufacturer.
 - .2 Certification tester
 - .1 Accuracy
 - .1 Level III accuracy in accordance with ANSI/TIA-1152
 - .2 Independent verification of accuracy
 - .3 Acceptable manufacturers
 - .1 Fluke Networks
 - .2 Permanent Link Adapters
 - .1 RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C

- .2 Twisted pair Category 5e or 6A cords are not permitted as their performance degrades with use and can cause false Return Loss failures
- .3 Results Storage
 - .1 Must be capable of storing > 10,000 results for all measurements found in 2.1.B.4 below
- .4 Measurement capabilities
 - .1 Wire Map
 - .2 Length
 - .3 Propagation Delay
 - .4 Delay Skew
 - .5 DC Loop Resistance
 - .6 DC Resistance Unbalance
 - .7 Insertion Loss
 - .8 NEXT (Near-End Crosstalk)
 - .9 PS NEXT (Power Sum Near-End Crosstalk)
 - .10 ACR-N (Attenuation to Crosstalk Ratio Near-End)
 - .11 PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
 - .12 ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - .13 PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - .14 Return Loss
 - .15 TCL (Transverse Conversion Loss)
 - .16 ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - .17 Time Domain Reflectometer
 - .18 Time Domain Xtalk Analyser
 - .19 PS ANEXT (Power Sum Alien Near-End Crosstalk)
 - .20 Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk)
 - .21 PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far- End)
 - .22 Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

- .3 PC Software
 - .1 Windows® based.
 - .2 Must show when 3 dB and 4 dB rules are applied
 - .3 Re-certification capability, where results must have their Cable IDs suffixed with (RC).
 - .4 Built in PDF export – no additional third party software permitted.
 - .5 Built-in statistical analysis.

Part 3 Execution

3.1 GENERAL

- .1 All outlets, cables, patch panels and associated components shall be fully assembled and labelled prior to field-testing. Any testing performed on incomplete systems will be redone on completion of the work.

3.2 CATEGORY 6A BALANCED TWISTED PAIR CABLE TESTING

- .1 Field-test instruments will have the latest software and firmware installed.
- .2 Permanent Link test results including the individual frequency measurements from the tester will be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- .3 Permanent Link testing will be performed on each cabling segment (connector to connector). Sampling is not acceptable.
- .4 Alien Crosstalk testing will be performed using a sampling plan. An acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in ISO 2859- 1 for populations of up to 500,000 links will be used. The following table represents this sampling level.
- .5 Disturbed (Victim) links chosen for Alien Crosstalk testing will be an equal combination of short, medium and long links.
- .6 Permanent Link adapters made from twisted pair Category 5e or 6A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
- .7 The installer will build a reference link. All components will be anchored so it is not possible to disturb them. The technician is to conduct a Category 6A Permanent Link test each day to ensure no degradation of the tester or its Permanent Link adapters.
- .8 Wire Map Measurement
 - .1 The wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors. For each of the 8 conductors in the cabling, the wire map indicates:
 - .1 Continuity to the remote end
 - .2 Shorts between any two or more conductors
 - .3 Reversed pairs

- .4 Split pairs
- .5 Transposed pairs
- .6 Distance to open on shield
- .7 Any other miss-wiring
- .2 The correct connectivity of telecommunications outlets/connectors is defined in ANSI/TIA-568-C.2. T568A will be used. The field tester will use this colour scheme.
- .9 Length Measurement
 - .1 The length of each balanced twisted pair will be recorded.
 - .2 Since physical length is determined from electrical length, the physical length of the link calculated using the pair with the shortest electrical delay will be reported and used for making the pass or fail determination.
 - .3 The pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in ANSI/TIA-568-C.2 plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a Permanent Link, the length measurement can be 325 ft. (99 m) before a fail is reported.
- .10 Propagation Delay measurement is the time it takes for a signal to reach the end of the link.
 - .1 The measurement will be made at 10 MHz per ANSI/TIA-1152.
 - .2 The propagation delay of each balanced twisted pair will be recorded.
 - .3 Is not to exceed 498 ns per ANSI/TIA-568-C.2 Section 6.3.18.
- .11 Delay Skew measurement is the difference in propagation delay @ 10 MHz between the shortest delay and the delays of the other wire pairs.
 - .1 The delay skew of each balanced twisted pair will be recorded.
 - .2 Is not to exceed 44 ns per ANSI/TIA-568-C.2 Section 6.3.19.
- .12 DC Resistance
 - .1 Often reported as Resistance, is the loop resistance of both conductors in the pair.
 - .2 Is not specified in ANSI/TIA-1152, but will be recorded for all four pairs.
- .13 DC Resistance Unbalance
 - .1 Often reported as Resistance Unbalance, is the difference in resistance of the two wires within the pair.
 - .2 Is not specified in ANSI/TIA-1152 for a Permanent Link, but will be recorded for all four pairs.
- .14 Insertion Loss is the loss of signal strength over the cabling (in dB).
 - .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz

- .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .2 Worst case will be reported for all four pairs in one direction only.
 - .3 Reported margins found to be within the accuracy of the field tester will be marked with an asterisk (*).
 - .4 Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.7.
- .15 NEXT (Near-End Crosstalk) is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
- .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .5 Will be measured in both directions. (12 pair to pair possible combinations)
 - .6 Both worst case and worst margins will be reported.
 - .7 Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA- 568-C.2 Section 6.3.8.
 - .8 Reported margins found to be within the accuracy of the field tester will be marked with an asterisk (*).
 - .9 The Time Domain Xtalk data will be stored for any marginal or failing NEXT results.
- .16 PS NEXT (Power Sum Near-End Crosstalk) is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
- .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .2 Will be measured in both directions. (8 pair possible combinations)
 - .3 Both worst case and worst margins will be reported.
 - .4 Is not to exceed the Category 6 and 6A Permanent Link limits found in ANSI/TIA- 568-C.2 Section 6.3.9.
 - .5 Reported margins found to be within the accuracy of the field tester will be marked with an asterisk (*).

- .6 The Time Domain Xtalk data will be stored for any marginal or failing PS NEXT results.
- .17 ACR-N (Attenuation Crosstalk Ratio Near-End) is a calculation of NEXT minus Insertion Loss of the disturbed pair in dB.
 - .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .2 Will be calculated in both directions.
 - .3 Is not specified in ANSI/TIA-1152, but will be recorded for all 12 possible combinations.
- .18 PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-End) is a calculation of PS NEXT minus Insertion Loss of the disturbed pair in dB.
 - .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .2 Will be calculated in both directions.
 - .3 Is not specified in ANSI/TIA-1152, but will be recorded for all 8 possible combinations.
- .19 ACR-F (Attenuation Crosstalk Ratio Far-End) is a calculation of FEXT minus Insertion Loss of the disturbed pair in dB.
 - .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .2 Will be measured in both directions. (24 pair to pair possible combinations)
 - .3 Both worst case and worst margins will be reported.
 - .4 Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.11.
 - .5 Reported margins found to be within the accuracy of the field tester will be marked with an asterisk (*).
- .20 PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End) is a calculation of PS FEXT minus Insertion Loss of the disturbed pair in dB.

- .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .1 31.25 – 100 MHz: 250 kHz
 - .2 100 – 250 MHz: 500 kHz
 - .3 250 – 500 MHz: 1000 kHz
- .2 Will be measured in both directions. (8 pair possible combinations)
- .3 Both worst case and worst margins will be reported.
- .4 Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.13.
- .5 Reported margins found to be within the accuracy of the field tester will be marked with an asterisk (*).
- .21 Return Loss is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
 - .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .2 Will be measured in both directions. (8 pair possible combinations)
 - .3 Both worst case and worst margins will be reported.
 - .4 Will be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
 - .5 Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.6.
 - .6 Reported margins found to be within the accuracy of the field tester will be marked with an asterisk (*).
 - .7 The Time Domain Reflectometer data will be stored for any marginal or failing Return Loss results.
- .22 TCL (Transverse Conversion Loss) is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
 - .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .2 Will be measured in both directions.

- .3 Is not specified in ANSI/TIA-1152 for a Permanent Link, but will be recorded for all 8 possible combinations.
- .23 ELTCTL (Equal Level Transverse Conversion Transfer Loss) is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
 - .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .2 Will be measured in both directions.
 - .3 Is not specified in ANSI/TIA-1152 for a Permanent Link, but will be recorded for all 8 possible combinations.
- .24 PS ANEXT (Power Sum Alien Near-End Crosstalk) (Category 6A)
 - .1 Takes into account the combined alien crosstalk (statistical) on a receive pair from all external near-end disturbers operating simultaneously.
 - .2 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .3 The disturbed (victim) link will have links to the left and right of it and if present, links above and below it.
 - .4 Disturber cables will include all links within the same bundle as the disturbed (victim) link and adjacent links
 - .5 Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it will be measured from the patch panel end only.
 - .6 Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.21.
- .25 Average PS ANEXT (Power Sum Alien Near-End Crosstalk) (Category 6A) is calculated by averaging the individual PSANEXT loss values, in dB, for all four pairs in the disturbed (victim) link.
 - .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 .100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz

- .2 Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.22.
- .26 PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End) (Category 6A)
 - .1 AFEXT loss is the coupling of crosstalk at the far-end from external link pairs into a disturbed (victim) pair of the 4-pair link under test. PS AACR-F is the calculated power sum from all external pairs into the disturbed (victim) pair.
 - .2 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .3 The disturbed (victim) link will have links to the left and right of it and if present, links above and below it.
 - .4 Disturber cables will include all links within the same bundle as the disturbed (victim) link and adjacent links
 - .5 Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it will be measured from the patch panel end only.
 - .6 Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.25.
- .27 Average PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End) (Category 6A) is calculated by averaging the individual PS AACR-F values, in dB, for all four pairs in the disturbed (victim) link.
 - .1 The frequency resolution will be:
 - .1 1 – 31.25 MHz: 150 kHz
 - .2 31.25 – 100 MHz: 250 kHz
 - .3 100 – 250 MHz: 500 kHz
 - .4 250 – 500 MHz: 1000 kHz
 - .2 The disturbed (victim) link will have links to the left and right of it and if present, links above and below it.
 - .3 Disturber cables will include all links within the same bundle as the disturbed (victim) link and adjacent links
 - .4 Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it will be measured from the patch panel end only.
 - .5 Is not to exceed the Category 6A Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.26.

3.3 ADMINISTRATION

- .1 Test results documentation
 - .1 Test results saved within the field-test instrument will be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records will be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”. The file format, CSV (comma separated value), does not provide adequate protection of these records and will not be used.
 - .2 Alien Crosstalk measurements will be stored to a PC upon completion of the test.
 - .3 The test results documentation will be available for inspection by the Communications Consultant during the installation period and will be passed to the Communications Consultant within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer will retain a copy to aid preparation of as-built information.
 - .4 The database for the complete project, including twisted-pair copper cabling links, if applicable, will be stored and delivered via Aconex to Consultant acceptance of the building. The Communications Contractor will include the software tools required to view, inspect, and print any selection of the test reports.
 - .5 Circuit IDs reported by the test instrument shall match the specified label ID. For Permanent Link testing, the detailed test results documentation data is to be provided in an electronic database for each tested balance twisted-pair and will contain the following information:
 - .1 The overall Pass/Fail evaluation of the link-under-test
 - .2 The date and time the test results were saved in the memory of the tester
 - .3 The identification of the customer site as specified by the end-user
 - .4 The name of the test limit selected to execute the stored test results
 - .5 The name of the personnel performing the test
 - .6 The version of the test software and the version of the test limit database held within the test instrument
 - .7 The manufacturer, model and serial number of the field-test instrument
 - .8 The adapters used
 - .9 The factory calibration date
 - .10 Wire Map
 - .11 Propagation Delay values, for all four pairs
 - .12 Delay Skew values, for all four pairs
 - .13 DC Resistance values, for all four pairs

- .14 DC Resistance Unbalance, values for all four pairs
 - .15 Insertion Loss, worst case values for all four pairs
 - .16 NEXT, worst case margin and worst case values, both directions
 - .17 PS NEXT, worst case margin and worst case values, both directions
 - .18 ACR-F, worst case margin and worst case values, both directions
 - .19 PS ACR-F, worst case margin and worst case values, both directions
 - .20 Return Loss, worst case margin and worst case values, both directions
 - .21 TCL, worst case values both directions
 - .22 ELTCTL, worst case values, both directions.
 - .23 Time Domain Crosstalk data if the link is marginal or fails
 - .24 Time Domain Reflectometer data if the link is marginal or fails
- .2 For Alien Crosstalk testing, the detailed test results documentation data is to be provided in an electronic database for each tested balance twisted-pair and will contain the following information
- .1 The overall Pass/Fail evaluation of the link-under-test
 - .2 The date and time the measurements were made
 - .3 The identification of the customer site as specified by the end-user
 - .4 The name of the test limit selected to execute the stored test results
 - .5 The name of the personnel performing the test
 - .6 The version of the test software
 - .7 PS ANEXT, worst case margin for all four pairs
 - .8 Average PS ANEXT, worst case margin
 - .9 PS AACR-F, worst case margin for all four pairs
 - .10 Average PS AACR-F, worst case margin

3.4 **CATEGORY 5e INSTALLATION TESTING**

- .1 Multi-pair Category 5e backbone cable testing will consist of testing each cable pair for opens, shorts, grounds, crosses and pair reversal. Examine any faulty pairs and correct the problem if it is caused by improper termination. If termination is proper, tag bad pairs at both ends and note on termination sheets. Replace any damaged or faulty cables, or connectors at no cost.
- .2 Category 5e Inter backbone cable testing will consist of testing each cable pair for opens, shorts, grounds and pair reversal. Examine any open and shorted pairs to determine if the problem is caused by improper termination. If termination is improper, tag bad pairs at both ends and note on termination sheets.
- .3 The test results will be submitted to the Consultant upon completion of testing the installed cables.

END OF SECTION

Part 1 General

1.1 COMMUNICATIONS ROOMS OVERVIEW

- .1 EF (Entrance Facilities) – The EF is an environmentally controlled space consisting of the pathways(s), space(s), cables, connecting hardware, protection devices and other passive and active equipment that support the access and service provider. The functions of the EF are:
 - .1 Demarcation point between the access and service provider cabling and equipment and the facility’s network infrastructure.
 - .2 Electrical protection for inter-building campus backbone and access and service provider cabling. Electrical protection is governed by local electrical codes.
 - .3 Connection point between outside plant cabling and building cabling that is accomplished by splicing or other means.
 - .4 The Cellular Distributed Antenna System (DAS) head end location.
- .2 Main Equipment Room (MER) – The MER is an environmentally controlled spaces that is located on level 01. The MER houses:
 - .1 The intermediate cross-connect
 - .2 Core equipment for building systems such systems as Building Automation and Management, Security, Access Control, Audio Visual and Video Conferencing.
 - .3 The MER is also used as the local Telecommunications Room for level 01
- .3 TR (local Telecommunications Room) – The TR is an environmentally controlled space that provides a common access point for pathways, backbone cabling and horizontal cabling. The TR may also contain cabling used for cross-connection. The horizontal cross-connect (HC) is located in the TR. The TR houses:
 - .1 Horizontal and backbone cables to connecting hardware.
 - .2 Telecommunication equipment, connecting hardware and splice closures serving a portion of the building. The TR will not house PABX, Servers, Core Equipment, Network Storage equipment, etc.
 - .3 Provide for the administration and routing of equipment cords from the HC to the telecommunications equipment.
 - .4 IT racks will be alternate between passive and active infrastructure (e.g. rack 1 is dedicated for passive infrastructure, rack 2 is dedicated for active equipment, and so on.).

1.2 SUBMITTALS

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

1.3 AS-BUILT DOCUMENTATION

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

Part 2 Products

2.1 EQUIPMENT RACKS / CABINETS

- .1 Two Post Equipment Rack
 - .1 Free standing 2286 mm high (48 rack units).
 - .2 2-post racks c/w RU markings (RU1 at top & RU48 at bottom) on front and rear posts and rails.
 - .3 Seismic Zone 4 NEBS Telcordia GR-63-CORE certified.
 - .4 Must provide 482.6 mm (19") rack mount capability for rack mountable components.
 - .5 Must provide 48 rack units of vertical mounting space.
 - .6 Must have 10-32 tapped mounting holes front and rear.
 - .7 Will be black in colour.
 - .8 Racks will be 610 mm wide
 - .9 Product: Electron Metal RKZFR2-194400 or approved equal.
- .2 Wall Mount Brackets
 - .1 Minimum Depth: 146mm (3 rack units)
 - .2 Product: Electron Metal WMBVER 190305 or approved equal.

2.2 CABLE MANAGEMENT SYSTEMS (CMS)

- .1 Vertical Cable Management System
 - .1 Double sided
 - .2 Front Channel
 - .1 305mm wide between racks; 152mm wide at end unit. 254mm deep
 - .3 Rear Channel
 - .1 305mm wide between racks; 152mm wide at end unit. 254mm deep
 - .4 Must be equipped with removable doors and straps, removable side fingers, access cut-outs at the back, and 3 sets of removable spools per front channel to take up patch cable slacks.
 - .5 The back of the cable trough must have stances to provide fastening for Horizontal cabling to the back of the trough.
 - .6 CMS must be gangable.
 - .7 Will be black in colour (including doors).
 - .8 Product (305mm wide): Commscope 760089375 | VCM-DS-84-12B or approved equal.
 - .9 Product (152mm wide): Commscope 760089342 | VCM-DS-84-6B or approved equal.

- .2 Horizontal Cable Management.
 - .1 Horizontal cable manager at the top of each rack and between every 48-port patch panel as indicated on the drawings.
 - .2 The horizontal cable manager will be a finger-type, single-sided, and compatible with the finger-type vertical manager.
 - .3 Product: Commscope 760072942 | HTK-19-SS-1U or approved equal.

2.3 UTP PATCH PANELS

- .1 Patch panels for UTP horizontal cabling will be a flat 1U modular 24-port unit or 2U modular 48-port unit, suitable for mounting on 482.6mm (19") racks. Refer to rack elevations on drawings.
- .2 All ports shall be populated with RJ45 Modular Jack, in accordance with Section 27 15 00.
- .3 Product (24-port unit): Commscope 760237040 | CPP-UDDM-SL-1U-24 or approved equal.
- .4 Product (48-port unit): Commscope 760237041 | CPP-UDDM-SL-2U-48 or approved equal.

2.4 OPTICAL FIBER PATCH PANELS

- .1 Patch panels for Fiber Optic cabling will be a modular, sliding tray, suitable for mounting on 482.6mm (19") racks. Refer to rack elevations on drawings.
- .2 All slots will be populated with bulkheads, in accordance with Section 27 13 23.
- .3 The specified fiber patch panel will have the ability to house Single Mode / Multi Mode fiber, fusion splice, pre-terminated fiber assemblies with MPO cassettes / bulkhead terminations simultaneously.
- .4 Equip with 24-fiber Duplex LC splice cassettes.
- .5 Product (1U-unit): Commscope 760231449 | SD-1U or approved equal.
- .6 Product (2U-unit): Commscope 760231456 | SD-2U or approved equal.
- .7 Product (4U-unit): Commscope 760231464 | SD-4U or approved equal.

2.5 FIBER SPLICE ENCLOSURES

- .1 Wall Mount Enclosure with spooling area.
- .2 Accommodates a minimum of 24 fibre strands.
- .3 Product: Commscope, Panduit or approved equal.

2.6 POWER DISTRIBUTION UNITS

- .1 Provide 3-phase 208V, 30A power distribution units (PDU) with alternating-phase outlets down the length of the unit and network monitoring.
- .2 Minimum C13 outlet count: 18
- .3 Minimum Cx outlet (dual C13 and C19 outlet) count: 18
- .4 Minimum 5-20R outlet count: 3

- .5 Quantities:
 - .1 Not used.
 - .1 Not used.
 - .2 Active IT Racks:
 - .1 One master PDU for every active IT rack as indicated on the drawings.
 - .2 One link PDU for every active IT rack as indicated on the drawings.
 - .3 One (1) spare master PDU and one (1) spare link PDU for the entire project.
- .6 Product(s):
 - .1 Master PDU: Server Technology C2WG48TE-YCMFAM99 or approved equal.
 - .2 Link PDU: Server Technology C2XG48TE-YCMFAM99 or approved equal.

2.7 IDC TERMINATION BLOCKS

- .1 Will be Belden, GigaBIX Mount, GigaBIX Connector, 25-pair, to terminate voice multi pair (25 pair) backbone cables.
- .2 Belden GigaBIX Wire Guard.
- .3 Belden GigaBIX Designation Strip,
- .4 Belden GigaBIX Management Ring
- .5 Belden GigaBIX cable management module (installed behind GigaBIX mount to facilitate cable routing).
- .6 Belden GigaBIX horizontal channel plate.

Part 3 Execution

3.1 COMMUNICATIONS ROOM FINISHES

- .1 Penetrations through walls, floors and ceilings will be fire-stopped using products based on the requirements of Fire Stop Systems 27 05 29 and in accordance with Section 27 05 28 Pathways for Communications Systems.
- .2 All walls will be to underside of slab. All walls will be lined with rigidly installed 20 mm (3/4"), AAA G1S plywood. The plywood panels will extend from floor level to a height of 2438mm. Expose certified stamped mark. Refer to Interiors Finishes list for coordination.
- .3 The only access from adjacent ceiling spaces will be by cable tray via Hilti Speed Sleeves or conduit in accordance with Section 27 05 28 Pathways for Communications Systems to allow connection to the horizontal and backbone pathways. Hallway cable tray will access the Communications room on the same floor by cable tray only.
- .4 The use of a pull pit in Communications Rooms will not be acceptable.

- .5 All floors will require anti-static dissipative flooring. Refer to Interiors Finishes list and Section 09 65 00 for coordination. Bond flooring per manufacturer's recommendations and TIA -J-STD-607B.

3.2 CLEANING

- .1 Prior to installing network equipment and switches, the Contractor will have the TRs professionally cleaned at the sub-micron level by a company that is specialized in cleaning critical environments. The cleaning will remove all construction related dust and debris from all surfaces including equipment racks and all components installed within them.
 - .1 Prior to receiving any network equipment from the Authority to install, the Contractor shall conduct air quality testing and provide the Consultant with a report and analysis of particle counts before and after the cleaning of TR's.
 - .2 The Contractor will provide clean room sticky mats and air scrubbers as required to keep the TR's clean until target substantial completion of the Facility is achieved.

3.3 SECURITY

- .1 Access Control:
 - .1 The Contractor will coordinate and arrange for installation of Communications Room's card access system prior to the installation of network equipment, with Communications Consultant and Owner.
 - .2 All entry doors to communication rooms will be equipped with a network access control card reader.
 - .3 Manual punch code locks are not permitted on any Communications Room doors.
- .2 Keys:
 - .1 Key will be cut to fit all the TR's within the same building.
 - .2 A copy of the key will be given to the Owner.
 - .3 If the TR is equipped with a supplementary door, no keys will be issued for these doors in order to ensure the audit trail through the access control system remains intact. Keys issued for the main entry doors that bypass the card reader should be limited for emergency access only.
 - .4 Refer to Section 08 71 00 for keying system.
- .3 All TR's will be equipped with CCTV camera(s). CCTV camera(s) will be used to identify people entering the room and general activity within the room in accordance to Section 28 23 00. Refer to drawings for the location of devices.
- .4 All TR's will be equipped with Intrusion Detection in accordance to Section 28 16 00. Refer to drawings for the location of devices.

3.4 EQUIPMENT RACKS / CABINETS (REFER TO DRAWINGS FOR SIZING)

- .1 Each rack / cabinet will be plumbed and levelled, and solidly bolted to the floor with bolts, washers and brackets. Bonding of rack to ground per TIA -J-STD-607B and Section 27 05 26.

- .2 Equipment racks / cabinets will be seismically restrained and approved per Seismic Engineer of record.
- .3 Where two or more racks are mounted side by side, the racks will have a double sided vertical manager installed in between and ganged with metal bolts and washers.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
 - .1 Section 27 05 00 – Common Works for Communications Systems
 - .2 Section 27 11 00 – Communication Room Fittings
 - .3 Section 27 13 13 – Communications Copper Backbone Cabling

1.2 LIST OF TERMS AS USED IN THIS SPECIFICATION

- .1 “ISP”: Inside Plant cabling
- .2 “OSP” Outside Plant cabling
- .3 “PIC”: Plastic Insulated Conductor
- .4 “PVC”: Polyvinyl Chloride
- .5 “PE”: Polyethylene
- .6 “CMP”: Communications Media Plenum plenum rating
- .7 “CMR”: Communications Media Riser riser rating
- .8 “TR”: Telecommunications Room

1.3 SCOPE

- .1 The Communications Contractor will, supply, install, test and certify a multi-conductor twisted pair backbone cabling system (including all patch panels, termination blocks, patch cords and cross connect wire) that will connect the MER to each Telecommunications Room/Closet/Enclosure in the Facility.
- .2 The backbone configuration will be a hierarchical star structure with separate dedicated cables from the MER to each Telecommunications Room.
- .3 In a TR and MER, Horizontal cables will be bundled separately from Intra-Building Backbone cables.
- .4 No backbone cables will be left un-terminated in a Telecommunications Room.
- .5 Copper Intra-Building Backbone Cables
 - .1 Copper backbone cabling consisting of Category 5e (4-pair) unshielded twisted-pair will be installed by the Communications Contractor, from the MER to each TR as shown on the drawings. Provide six (6) CAT5e cables to each TR.
 - .2 Multi-pair cable bundles entering GigaBIX mounts and the hinging of connectors will be on the jumper side of the mount.
 - .3 Backbone copper cables from the same Telecommunications Room must be grouped together and terminated sequentially on the GigaBIX connectors; group the cables from each Telecommunications Room together. Once the first riser is terminated and numbered, every other riser in its group continues the number sequence.

- .6 The Communications Contractor will supply, install, test and certify a multi-conductor twisted pair inter-building cabling run that will connect the new Health Science Centre MET to SW01. Cable routing and existing pathways are noted on the drawings. Terminate Category 5e cable 2 x 25-pair cable on the BIX frame at either end.

1.4 SUBMITTALS

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.
- .2 Submit shop drawings for:
 - .1 Cabling
 - .2 IDC termination (GigaBix)

1.5 AS-BUILT DOCUMENTATION

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.
- .2 Provide:
 - .1 Circuit Spreadsheet.

Part 2 Products

2.1 MULTIPAIR UNSHIELDED TWISTED PAIR CABLE

- .1 Conductors:
 - .1 Conductors of 24 AWG annealed solid copper.
 - .2 Conductors fully insulated, consisting of an inner layer of expanded polyolefin, covered with an outer layer (skin) of solid PVC.
 - .3 Twisted pair conductors, stranded into 25-pair bundles and into units.
 - .4 Colour Coding: Twisted pairs and units individually color-coded to industry standards (ANSI/ICEA Publications S-80-576, and TIA-230).
- .2 Core & Sheath
 - .1 Cable sheath consisting of an overall flame-retardant PVDF or equivalent jacket.
 - .2 Cable that is CEC rated as CMP as required by the authority having jurisdiction, and UL listed as such.
- .3 Performance:
 - .1 Electrical performance of the twisted pairs and overall cable that complies with TIA- 568-C requirements for Category 5e UTP cabling.
- .4 Inter-Building Application:
 - .1 Product(s): Commscope 874020906/10 | CS24 25PR WHITE CMP REEL

2.2 CATEGORY 5E 4-PAIR CABLE

- .1 Intra-building Application:
 - .1 Cable suitable for indoor installation, between floors in vertical riser system, utility tunnels, under access flooring, and through overhead ceiling space (in cable tray, conduit & hangers).
 - .2 Each and every cable run will have a continuous single cable, homogenous in nature. Splices are not permitted anywhere.
 - .3 Twisted pair PIC type, air core cable for intra-building cabling.
 - .4 Accepted Manufacturers: Commscope

2.3 TERMINATION EQUIPMENT

- .1 GigaBIX suitable for installation within a telecommunications facility for the termination of the backbone twisted pair cables and suitable for either wall or rack installations, vertically oriented for a wall mounted column configuration.
- .2 “GigaBIX” type.
- .3 GigaBIX accompanied by the quantity of management equipment, for both horizontal and vertical routing of cords and cross connect wires.
 - .1 GigaBIX kit, 300 pair, 5-pair based.
 - .2 Vertical management panel.
 - .3 Cable management module will be provided behind each GigaBIX mount.

2.4 CROSSCONNECT WIRE

- .1 Cross connect Wire, 1-Pair
 - .1 Cross connect wire suitable for installation within a telecommunications facility and fully compatible with the GigaBIX. Each and every cross connect wire manufactured from a single, continuous length of insulated wire, homogenous in nature. Splices are not permitted anywhere.
 - .2 Factory splices of insulated conductors are expressly prohibited.
 - .3 Conductors:
 - .1 Insulated Conductors: 24 AWG conductors of solid copper. Fully insulated conductors with a flame retardant thermoplastic material (such as PVC, or equivalent).
 - .2 Twisted Pairs: Two insulated conductors “twisted” into a “pair” (twisted pair), individually color-coded.

Part 3 Execution

3.1 INSTALLATION

- .1 Backbone Cable
 - .1 Cable runs will have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.

- .2 Placement
 - .1 Maintain a minimum bend radius of 20 times the cable diameter and 10 times the cable diameter after installation.
 - .2 Maintain pulling tension within manufacturer's limits.
 - .3 Place cables within designated pathways.
 - .4 Place and suspend cables in a manner to protect them from physical interferences or damage. Replace cables if damaged during installation.
 - .5 Place cables with no kinks, twists, or impact damage to the sheath.
 - .6 Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of the pull rope.
- .3 Routing
 - .1 When routing horizontally within Communications rooms, utilize the overhead cable support. When routing vertically within Communications rooms, utilize the vertical cable support (vertical basket tray) and provide cable ties every 610mm (24") on centre.
 - .2 Route cables a minimum of 150mm (6") away from power sources to reduce interferences from EMI.
 - .3 Provide minimum 7 meters sheathed cable slack loop at each end of the run. Coil and place the slack on wall outside and above the overhead cable tray.
- .4 Termination
 - .1 Properly strain-relieve cables at termination points per manufacturer's instructions.
 - .2 Terminate twisted pairs onto the GigaBIX in accordance with manufacturer's latest instructions and TIA-568C standard installation practices.
 - .3 Perform post-installation testing as described in the Testing for Communications specification.
- .2 GigaBIX
 - .1 Provide accessories required for a complete installation.
 - .2 Install cable management module layout such that the 1st cable management module starts at 203mm (8") from the wall and 457mm (18") from the floor.
 - .3 Mount GigaBIX plumb and square.
- .3 GigaBIX Distribution for Voice Tie Cables
 - .1 Install patch panels in data rack as per drawings.
 - .2 Provide 2x25 pair from the GigaBIX mount in the MER to a rack mounted patch panel in TR on Level 1.

- .3 Provide 6x Category 5e cables from TR on Level 1 to a rack mounted patch panel on each floor.
- .4 At the Main Cross-connect, provide one 1-pair cross connect to length from the equipment field to the backbone.
- .5 Refer to drawings for details.
- .6 Utilize the horizontal and vertical management components to properly route the cross connect wire.
- .7 Splices in cross connect wire are prohibited.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

- .1 Section 27 05 00 – Common Works for Communications Systems
- .2 Section 27 05 53 – Identification for Communication Systems
- .3 Section 27 08 11.01 – Testing for Communications Fiber
- .4 Section 27 11 00 – Communication Room Fittings
- .5 Section 27 11 30 – Campus Communications Hub Fittings
- .6 Section 27 53 19 –Distribution Antenna Systems
- .7 Section 28 23 00 – Video Surveillance System

1.2 SCOPE

- .1 The Communications Contractor shall supply, install, test and certify an intra-building fibre backbone cabling system that will connect the MER to each Telecommunications Room and AV/IT room in the Facility.
- .2 The Communications Contractor shall supply, install, test and certify an inter-building fibre entrance cabling system that will connect the new Health Science Centre MER to building SE12 (primary path) and NE25 (diverse path). Cable routing and existing pathways are noted on the drawings.
- .3 The Communications Contractor shall supply, install, test and certify an inter-building fibre link between the new Health Science Centre and the Canada Way Receiving Substation (CWRS). Cable routing and existing pathways are noted on the drawings.
- .4 The Communications Contractor shall supply, install, test and certify fibre optical patch hardware and cables within Telecommunication Room and Campus Communications Hub.
- .5 Additional requirements specific to fibre optics installation within the Health Sciences Centre for the DAS system can be found in those respective specification sections. Those requirements are in addition to, or modify the requirements in this section.

1.3 LIST OF TERMS AS USED IN THIS SPECIFICATION

- .1 In addition, define the following list of terms as used in this specification as follows:
 - .1 “MM”: Multimode (Fiber type OM5).
 - .2 “OFNP”: Optical Fiber Non-conductive, plenum rated.
 - .3 “OFNR”: Optical Fiber Non-conductive, riser rated.
 - .4 “OFCP”: Optical Fiber Conductive, plenum rated.
 - .5 “OFCR”: Optical Fiber Conductive, riser rated.
 - .6 “PVC”: PolyVinyl Chloride.

- .7 “SM”: Single mode (fiber type OS2).
- .8 “MER”: Main Equipment Room.
- .9 “TR”: Telecommunications Rooms.
- .10 “ER”: Entrance Room.
- .11 “AV/IT”: Audio-Visual/Information Technology Rooms.

1.4 SUBMITTALS

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.
- .2 Submit shop drawings for:
 - .1 Fiber Cabling (including patch cables and pre-term trunk cables),
 - .2 Cassettes, and
 - .3 Patch panels
 - .4 Fibre Management Components

1.5 AS-BUILT DOCUMENTATION

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.
- .2 Provide:
 - .1 Circuit Spreadsheet.
 - .2 Optical Fiber test results
 - .3 Pre-terminated Factory Test Results for each Component (with unique identifier).

Part 2 Products

2.1 FIBER CABLING

- .1 Fiber Optic Intra-building (Indoor) Backbone Cables
 - .1 Between MER and each TR & AV/IT room:
 - .1 Indoor/outdoor, plenum distribution cable, interlocking aluminum armored with plenum jacket
 - .2 Product(s): Commscope 760127837 | P-048-DZ-8W-FMUYL
 - .2 Fibre Optic Inter-building (Indoor/Outdoor) Entrance Cables
 - .1 Product(s): Commscope 760149724 | P-072-LZ-8W-F12BK/25D
 - .3 Fibre strand count is identified on the drawings.

2.2 PATCH CABLES

- .1 Cord assembled from a single, continuous length of cordage, homogenous in nature; Splices are not permitted.
- .2 Cords terminated at both ends via specified connector type.
- .3 Patch Cables:

- .1 LC/APC to LC/APC:
 - .1 Single-mode: Commscope FEWLALA42
- .2 LC/APC to SC/APC:
 - .1 Single-mode: Commscope FEWLASA42
- .4 Quantity:
 - .1 The Communications Contractor will provide and, where required, install single mode patch cords of the correct length for all end-use and telecommunications equipment in sufficient quantity to make each device and system in the Facility fully operational.
 - .2 The Communications Contractor will additional spare multimode and single mode patch cords. The amount will be equal to six (6) spare single mode patch cords for each fiber patch panel installed in the Facility.
- .5 Patch cable lengths to be confirmed with Owner prior to ordering.

2.3 TERMINATION EQUIPMENT

- .1 Provide sliding tray panels in accordance to Section 27 11 00.

2.4 SPLICE CASSETTES

- .1 LC, OS2 fibre cassette with pigtails
- .2 Fibre strand count per bulkhead: 12
- .3 Product(s): Commscope 760221747 | PNL-CS-12LCW-PT

2.5 FIBER MANAGEMENT COMPONENTS

- .1 Velcro Cable Ties
 - .1 Width: 19mm (0.75")

Part 3 Execution

3.1 INSTALLATION

- .1 Fiber Optic Installation
 - .1 The following requirements must be met to gain system acceptance.
 - .1 Run the cable along the route identified on the plan drawings
 - .2 Install materials and equipment in accordance with applicable standards, codes, requirements and recommendations of national, provincial and local authorities having jurisdiction and with manufacturer's printed instructions.
 - .3 Adhere to manufacturers' published specifications for pulling tension, minimum bend radii and sidewall pressure when installing cables.
 - .4 Any scoring or pitting within the fiber core (regardless of test result) will result in re-termination by the Contractor using a new connector.
 - .5 Provide a minimum of 7 meters of fiber optic cable slack at both ends of all cables, unless otherwise noted on the drawings (the

- greater of 7 metres or length indicated on drawings shall be provided).
- .6 All single-mode fiber will be fusion spliced utilizing 900 micron pigtails supplied by the Contractor. The fusion splicer used must be fully automated with full X and Y alignment and will employ fusion splice loss estimation. Fiber splice protection will be via 3M heat shrink sleeves.
 - .7 Signal attenuation:
 - .1 Any splice loss must not exceed 0.3 dB.
 - .2 Any connector loss must not exceed 0.5 dB.
 - .3 The loss along the length of the cable must not exceed 0.5dB/km.
 - .4 If test results show attenuation out of specification limits, then the Contractor is responsible to troubleshoot the link and determine corrective procedures.
 - .8 No manual fusion splicing will be performed.
 - .9 Fiber cable preparation, pigtail routing, and forming within the splice or distribution panel will be as per manufacturer's training and printed instructions.
 - .10 Prior to installation, the Contractor shall test the fibre optic cable with an OTDR instrument to verify that the cable has not been damaged during shipment. Readings obtained shall be used later for comparison with test acceptance data and included in the as-built documentation. Refer to Section 27 08 11 for testing requirements.
 - .11 All cabling shall be labelled in accordance to Section 27 05 53.
- .2 Patch Cables, Termination Equipment, Cassettes & Panels, Connectors
 - .1 Per industry standards and modified per manufacturer's recommended practices, and
 - .2 Modified by the requirements of Sections:
 - .1 27 11 00 – Communication Room Fittings
 - .2 27 53 19 –Distribution Antenna Systems

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
 - .1 Section 27 05 00 – Common Works for Communications Systems
 - .2 Section 27 05 28 – Pathways for Communications Systems
 - .3 Section 27 05 53 – Identification for Communications Systems
 - .4 Section 27 08 11.01 – Testing for Horizontal Category 6a
 - .5 Section 27 11 00 – Communication Room Fittings
 - .6 Section 27 21 33 – Data Communications Wireless Access Points

1.2 SYSTEM DESCRIPTION

- .1 The Communications Contractor will supply, install, test and certify a horizontal Category 6A structured cabling subsystem for the Facility.
- .2 Horizontal cable forms part of the structured cabling system and shall be run from each workstation, data point, telephone, and wireless access point location to the communication room designated for the zone. The cable shall be terminated and tested on both ends in accordance with the project specifications and the most recent TIA-568-C standard.
- .3 This section also describes any cords, cross-connect wire, devices, and adapters required to connect the OSP, riser, and horizontal cabling as called for in these specifications and related drawings.

1.3 SUBMITTALS

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.
- .2 Submit shop drawings for:
 - .1 Cabling
 - .2 Faceplates
 - .3 Jacks/inserts

1.4 AS-BUILT DOCUMENTATION

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.
- .2 Provide:
 - .1 Circuit Spreadsheet.

Part 2 Products

2.1 CATEGORY 6A HORIZONTAL CABLE

- .1 All horizontal cable and associated jacks, connectors, patch panels and faceplates will be Category 6A and manufactured by Commscope.

- .2 The installed system shall utilize a cable no larger than 0.285" O.D. while supporting IEEE proposed Type 4 PoE performance (100W) over the full channel length.
- .3 The installed system shall utilize a cable design supportive of heat dissipation such that no more than 9.5C of temperature rise occurs inside a 100-cable bundle as PSE power reaches 90W over 100 meters.
- .4 Horizontal cable shall include 4 conductor pairs with a minimum wire gauge of 23 AWG
- .5 All cabling shall be CMP plenum rated.
- .6 Cable jacket colour shall be blue.
- .7 Product: Commscope UN874035114/10 | CS44P BLU C6A 4/23 U/UTP CPK 1KFT.

2.2 COMMUNICATIONS ROOM COPPER PATCH CORDS

- .1 Provide one (1) Category 6A patch cord per horizontal cable installed at the communications room
- .2 Provide additional spare Category 6A patch cords in excess of the quantity required by 2.2.1. The formula used to determine the quantity will be 10% x the total number of network switch ports in the Facility on opening day. The length of spare patch cords shall match the ratios indicated in 2.2.6.
- .3 All patch cords shall be counted and provided to the Owner prior to the commencement of any work on site.
- .4 The patch cable conductor gauge shall be no larger than 28 AWG.
- .5 Patch cable jacket colour shall be black.
- .6 Lengths:
 - .1 Minimum patch cord cable to patch between the panel jacks and the switch ports shall be 2538mm (8'). However, other lengths will be required for this application.
 - .2 For AV equipment that resides in separate racks, longer patch cables will be used to route neatly through the horizontal and vertical cable managers based on shortest path. The cable tray shall not be used to patch between IT switches and AV equipment.
 - .3 At a minimum, provide patch cables with the following lengths:
 - .1 Two-hundred (200) 12192mm (40') patch cords.
 - .2 Two-hundred (200) 9144mm (30') patch cords.
 - .3 Two-hundred (200) 7620mm (25') patch cords.
 - .4 Three-hundred (300) 6096mm (20') patch cords.
 - .5 Four-hundred (400) 4572mm (15') patch cords.
 - .6 One-hundred (100) 1828mm (6') patch cords.
 - .7 Two-hundred (200) 1219 (4') patch cords.
 - .8 All remaining patch cords will be 2438mm (8').

- .4 Patch cord lengths to be confirmed with Owner prior to ordering.
- .7 Product: Commscope CO199K2-01 | MiNo6A-BK

2.3 WORK AREA COPPER EQUIPMENT CORDS

- .1 Provide one (1) Category 6A equipment cord per horizontal cable installed at the communications room.
- .2 All equipment cords shall be counted and provided to the Owner prior to the commencement of any work on site.
- .3 Provide plenum rated equipment cords for any horizontal cable terminated in the plenum ceiling space. This includes, but not limited to:
 - .1 AV communication outlets.
 - .2 WAP outlets.
 - .3 CCTV outlets.
- .4 Lengths:
 - .1 One-hundred (100) 12,192mm (40') equipment cords.
 - .2 One-hundred (100) 10,668 (35') equipment cords.
 - .3 Two-hundred (200) 9144mm (30') equipment cords.
 - .4 Two-hundred (200) 7620mm (25') equipment cords.
 - .5 Three-hundred (300) 6096mm (20') equipment cords.
 - .6 Three-hundred (300) 4572mm (15') equipment cords.
 - .7 Two-hundred (200) 1219mm (4') equipment cords.
 - .8 Two-hundred (200) 1828mm (6') equipment cords.
 - .9 Two-hundred (200) 2438mm (8') equipment cords.
 - .10 All remaining equipment cords will be 3048mm (10').
 - .11 Work area equipment cord lengths to be confirmed with Owner prior to ordering.
- .5 Product (plenum-rated): UC1AA22-0Z | UNC10G-P-BL
- .6 Product (non-plenum-rated): UC1AAA2-01 | UNC10G-BK

2.4 CROSS-CONNECT WIRE

- .1 Contractor will supply and install cross connection wires. All voice cross connections will be neatly routed via D-rings and bundled with Velcro wraps.
- .2 Wires will be 24 AWG solid tinned copper, 1-pair Category 5e. Conductors will be insulated with semi-rigid PVC. One insulated conductor in a pair will be white and the other in visibly distinct solid colour. Pair-untwist will not exceed 75mm from the point of termination.
- .3 The quantity of cross connection wires will be 24 pairs per 24 port voice tie cable patch panel, plus 10% spare.

2.5 COMMUNICATIONS CONNECTORS (JACK INSERTS)

- .1 Category 6A UTP connectors shall be unshielded, with strain relief, 8-pin modular jacks (RJ-45-style) terminated in T568A Wire Map configuration. The Jacks must accept RJ-45 modular plugs without causing any damage or degradation to the connectors or pins.
- .2 Approved colour for 8-pin modular jacks is alpine white.
- .3 Product: Commscope 760241147 | USL10G-A.WHT

2.6 SURFACE MOUNT BOXES

- .1 Surface Mount boxes will be used for Wireless Access Point and Video Surveillance Camera termination.
- .2 Product (2-port): Commscope 1-1116698-3
- .3 Product (1-port): Commscope 1-1116697-3

2.7 DEVICE PLATES

- .1 Each outlet shall be finished with a Faceplate kit, non-labeled, 1-gang, 6-port coupled with RJ45 Modular Jacks in accordance with this Section.
- .2 Ports with no cable terminated shall have matching alpine white blanks.
- .3 Approved Colour: Alpine White
- .4 Faceplate kit product: Commscope 1-2111025-3
- .5 Blanking insert product: Commscope 1-1116412-3

2.8 OUTDOOR-RATED CATEGORY 6A HORIZONTAL CABLE

- .1 Product: Commscope 760178129 | 1592A BLK C6A 4/24 F/UTP R1000

2.9 SURGE PROTECTIVE DEVICE

- .1 Product: DTK-110C6APOE

Part 3 Execution

3.1 OVERVIEW

- .1 The horizontal configuration will be a star structure with separate dedicated continuous cables run from the servicing zone Communications Room to the outlets on the same floor.
- .2 The maximum length of horizontal cable will not exceed 90 m.
- .3 Where there is more than one Communications Room on the same floor, boundary lines are indicated on drawings. Horizontal cables shall not cross the lines to another zone to be served by another Communications room.
- .4 In a Communications Room, horizontal cables will be bundled separately from Inter and Intra backbone cables.
- .5 All horizontal cables will be terminated at both ends. CMP rated Velcro straps will be used to support the cables depending on location. The straps will be loosely tightened in such a manner that it can slide around cable bundle. Zip ties are not permitted.

- .6 Each cable will be terminated at workstation outlets on eight-position modular jacks with pin/pair assignment wired to T568A.
- .7 The Communications Contractor will leave slack in the cable at the outlet box following termination. Too much slack at the point of termination may result in testing failures and too little slack can compromise future maintenance. Minimum cable slack for CAT6A cabling is as follows:
 - .1 3000mm (10') in the communications room
 - .2 300mm (1') at the work area
- .8 The Communications Contractor will neatly dress all cables within the Communications Room to follow building lines, the objective being to provide a reasonable amount of slack into each cable run, while at the same time provide neatness and promote order as the cables migrate from the point-of-entry to the termination point.
- .9 The cable pair twist must be maintained as per the Manufacturer specifications at the point of termination.
- .10 Refer to the following documents for guidelines on installation:
 - .1 Manufacturer Installation Guideline Documentation.
 - .2 TIA-568-C and C.1, as well as Drawings for installation.

3.2 HORIZONTAL CABLE INSTALLATION

- .1 Faceplate Configuration
 - .1 Communications Outlet
 - .1 A typical Communications outlet will have two 4-pair cables (Jacks 1 and 2 on a 6-port faceplate). Populate jack inserts on faceplate starting at the top and move sequentially down once the first row is full.
 - .2 All UTP cable system work completed by the Communications Contractor must be inspected by the Consultant.
 - .3 Install materials in accordance with applicable standards, codes, requirements and recommendations of national, provincial and local authorities having jurisdiction and with manufacturer printed instructions.
 - .4 Adhere to manufacturer published specifications for pulling tension, minimum bend radii and sidewall pressure when installing cables.
 - .5 When installing, ensure cable is not subjected to stress due to contact with tray/conduit support mechanisms, bonding lugs or any metal burrs within the support structure. Conduit must have insulated throat connectors installed prior to pulling any cable.
 - .6 Particular care must be taken when working around corners and offsets.
 - .7 Cable dressing and termination procedures will confirm to the following requirements:
 - .1 All cable installation will be done in a neat and tidy fashion. All cable dressing within the entrance facility and communications rooms will follow building lines.

- .2 Cable will be neatly dressed with no crossovers within the bundle. The Consultant will have final approval of cable dressing quality and any workmanship issues. Bundles will be dressed using Velcro fasteners. Cables must not exhibit sheath deformation due to poor installation or bundle over-tightening. If cable dressing is not performed to the satisfaction of the Consultant, the Communications Contractor will be responsible to re-install or re-dress the bundles at no cost. Termination practices must strictly comply with manufacturer recommendations and all referenced wiring installation standards.
- .3 Particular care must be taken to limit sheath removal length and pair untwisting at point of termination.
- .4 Cables will be terminated in sequential order.
- .5 At each Communications outlet follow the same termination practices as stipulated for the Communications Room.
- .6 In Communications Room, horizontal cables will be bundled and terminated on patch panels. Refer to Drawings.
- .7 Horizontal distribution cables will be loosely bundled in no more than 24 cables.
- .8 Any cable damaged or exceeding recommended installation parameters during installation will be replaced by the Communications Contractor prior to final acceptance at no cost.
- .9 All cables will be terminated in Communications Rooms and at Communications outlets. Leave no cables un-terminated unless specified in drawings or as directed by the Consultant.

3.3 ACCESSIBILITY

- .1 Install all work in a manner that allows easy access for adjustment, operation and maintenance. Provide access panels where required to allow access to junction boxes and devices for maintenance purpose.
- .2 Locate access panels in service areas wherever possible. Do not locate in finished walls.

3.4 MISCELLANEOUS CABLES

- .1 The Owner does not accept hybrid or under-carpet cabling.

3.5 LIGHTNING PROTECTION

- .1 Primary Protectors for PoE equipment installed inside Communication Rooms:
 - .1 Provide Surge protectors on each Horizontal cable run entering the building.
 - .2 Provide a #6 AWG Green Insulated Bonding Conductor from either the Electrical Grounding Bus bar or the Communications Grounding Bus bar (whichever is closer).
 - .3 Daisy Chain the #6 ground between each Horizontal Protector.
 - .4 Bond the metallic conduit used for running the Horizontal 4-pair Circuits.

- .5 Note: the 65V Solid State modules are necessary for pass-through of PoE+ voltage. Surge Protector Installation is based on current CEC Code Section 60 and TIA 607.

END OF SECTION

1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.1 Section 27 05 00 – Common Works for Communications Systems

.2 Section 27 05 53 – Identification for Communications Systems

.3 Section 27 15 00 – Horizontal Cabling

1.2 SCOPE

.1 The Owner is responsible for:

.1 The procurement, configuration and commissioning of all hardware and software related to wireless network management systems and tools.

.2 The procurement of all standard vendor supplied access point mounting brackets, lightning arrestors and accessories required to install wireless hardware.

.3 Labelling and supplying the Contractor with wireless access points, antennas, mounting brackets, specialty mounting brackets and other standardized hardware based upon a mutually agreed to schedule.

.2 The Contractor is responsible for:

.1 Installation of Owner supplied wireless access points and accessories.

.2 Providing horizontal cabling, patch cords between access points and outlets, cable terminations and designated WAP outlets.

.3 Cable testing.

2 Products

2.1 CABLING

.1 See section 27 15 00 - Horizontal Cabling Section

2.2 ENCLOSURES

.1 Provide per section 08 31 00 - Access Doors and Panels.

3 Execution

3.1 WIRELESS INSTALLATION

.1 The responsibility of the Communications Contractor in the deployment of a wireless infrastructure are as follows:

.1 Supplying, installing, testing and certifying a horizontal cabling throughout the facility's ceiling spaces to connect wireless access points.

.2 Installing all access points, antennas and associated accessories and hardware as prescribed by Consultant's wireless design.

.1 Wireless network hardware provided to the Contractor for the interior of the Facility will not be installed until the building is enclosed, weather tight, temperature and humidity conditions are approximately the same as final conditions expected, wireless

cabling grid is installed and tested, most construction activities are complete and surfaces have been swept and treated for dust control. The Contractor will not be allowed to install wireless and wired network hardware until the Owner has inspected the interior building conditions and provided written approval to proceed with the installation.

- .2 Prior to receipt of wireless network hardware and components for installation, the Communications Contractor is required to provide the Consultant with as-built documentation of the wireless cabling identifying the cable IDs associated with each wireless communication outlet.
- .3 Upon receipt of wireless and wired network hardware and components, the Contractor will be financially responsible for any damage or disappearance of the Owner provided material due to improper handling and storage, negligence, fire, theft and environmental conditions during construction.
- .3 Moving wireless network hardware within 5 metres of telecommunications outlet as prescribed by the Owner after completion of post occupancy wireless surveys conducted by Owner. In addition to labour and equipment, the Contractor is required to cover all costs associated with moving access points such as replacement of ceiling tiles and the installation of sleeves through walls.
- .4 Installing two patch cords between each access point and its designated wireless outlet as specified. If required due to the ceiling type, the Contractor will install conduit to run the patch cords between the wireless communication outlet and the access point. In the Communications Room, the Contractor must also install two patch cords to connect the access point to the switch ports designated by the Owner.
- .5 Installing surge protectors in the Communications room and associated grounding for all outdoor access point locations.
- .6 If the mounting of wireless hardware requires the procurement of non-standard or specialty mounts, brackets, vanity skins or covers or the fabrication of custom solutions, the Contractor will be expected to bear all associated design, fabrication, procurement and installation costs. Furthermore, if alterations in the design, fabrication and installation of components provided by others are needed to install any aspect of the wireless infrastructure then the Contractor will be expected to bear the full cost of all such customization.

3.2 INSTALLATION (INDOOR)

- .1 Regardless of the location and mounting method of the wireless access point, maximum permanent link length is 90 meters.
- .2 Two horizontal cables will be installed to each wireless Communications outlet. Terminate two horizontal cables on jack.
- .3 Mounting Scenarios for different ceiling types:
 - .1 Solid (drywall) ceiling:

- .1 The dual horizontal cable runs are to be installed in conduit between the ceiling Communications outlet box and the nearest cable tray.
- .2 Patch cords are to be fished across solid ceilings between the ceiling Communications outlet box and the wireless access point location.
- .3 The standard patch cord length used to connect to the wireless access point is 20' / 6.1m. Store and support any slack length in the ceiling above the access point.
- .4 The ceiling Communications outlet box to be mounted above ceiling for the termination of horizontal runs.
 - .1 Ceiling Communications outlet box is a 100mm x 100mm x 100mm with a 100mm x 100mm shoe box steel cover for a decora strap.
 - .2 The ceiling Communications outlet box will be fastened directly to the ceiling's structural support member with a Caddy clip and/or screws no more than 305mm above the access hatch opening.
- .5 An access panel (305mm x 305mm) will be installed at the ceiling Communications outlet box location (painting is by the contractor).
- .6 Wireless access point installation (directly) to ceiling using vendor supplied mounting bracket.
- .7 All access points must be seismically restrained.
- .8 Label the faceplate, patch cords and the access hatch.
- .2 Exposed ceiling (Parkade, utility spaces, stairwells, etc.):
 - .1 The dual horizontal cable runs are to be installed in conduit between the ceiling Communications outlet box and the nearest zone box.
 - .2 Mount wireless access point to the box using mounting bracket or wireless enclosure.
 - .3 Ceiling Communications outlet box to be mounted to the ceiling for the termination of horizontal runs.
 - .1 Ceiling Communications outlet box is a 200mm x 200mm x 100mm with a solid cover plate. Locate a 2-port Surface jack Assembly inside the JB.
 - .2 The standard patch cord length used to connect to the wireless access point is 20' / 6.1m. Coil patch cord slack inside outlet box.
 - .4 All access points must be seismically restrained.
 - .5 Label the ceiling Communications outlet box, surface jack assembly and patch cords.
- .3 Accessible Ceiling (T-bar or wooden slats):

- .1 The dual horizontal cable runs are to be installed in conduit or non-continuous open supports (J-hooks) between the ceiling Communications outlet box and the nearest cable tray.
- .2 Patch cords are to be fished across ceilings between the ceiling Communications outlet box and the wireless access point location.
- .3 The standard patch cord length used to connect to the wireless access point is 20' / 6.1m. Store and support any slack length in the ceiling above the access point.
- .4 The ceiling Communications outlet box to be mounted above ceiling for the termination of horizontal runs.
 - .1 Ceiling Communications outlet box is a 100mm x 100mm x 100mm with a 100mm x 100mm shoe box steel cover for a decora strap.
 - .2 The ceiling Communications outlet box will be fastened directly to the ceiling's structural support member with a Caddy clip
- .5 Wireless access point installation (directly) to ceiling Main Tee using vendor supplied mounting bracket.
- .6 All access points must be seismically restrained.
- .7 Label the faceplate and patch cords.
- .4 In mounting scenarios that don't meet with the examples above, the Consultant is to be consulted.
- .5 At the communications room end, the wireless cabling from the same drop location shall be distributed evenly across patch panels for patching to different switches.
- .6 For all outdoor wireless access point installation, the applicable CEC and BC codes will govern the location, mounting, grounding and type of service cable and enclosures used.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SCOPE

- .1 Contractor shall include all labour, materials, tools, training, equipment and all necessary and related items for a complete and operational wireless clock system.
- .2 Wireless clock system shall be installed as indicated on the drawings and as specified herein.
- .3 Supply and install clocks as shown on the plans that are compatible with the existing campus wireless and synchronized Master Clock system.
- .4 The new clocks shall synchronize all other clocks in the buildings and with the existing campus Master Clock subsystem which in turn synchronizes to a standard time server (GPS, WWVB, NIST)
- .5 System to include:
 - .1 Master transmitter
 - .2 Repeater
 - .3 GPS receiver with bracket and required weatherproof cabling
 - .4 Clocks
- .6 All clocks shall adjust automatically for Daylight Savings Time in 1 hour and 30 minutes maximum.
- .7 Clocks shall be fully portable and finally located to suit the Owners requirements.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 27 05 00.
- .2 Shop drawings to include detail schematic and bill of materials with quantities.

1.4 OPERATING & MAINTENANCE DATA

- .1 In accordance with Section 27 05 00 – Common Works for Communications Systems.

1.5 WARRANTY/SERVICE

- .1 System warranty to cover one-year parts and labour from date of substantial performance. Manufacturers extended warranties on equipment shall apply if typically longer than one year.
- .2 System supplier to include a guarantee that service will be provided on the system within 24 hours of call origination during the warranty period.
- .3 During the warranty period the system installer at his expense will repair and replace all such defective work and other work to the new system, which fails or becomes defective during the term of warranty, provided that such failure is not caused by the improper usage or physical damage.

1.6 TRAINING

- .1 Provide complete and comprehensive training and demonstration sessions for the Owner.
- .2 Instruct personnel in operation, adjustment, and maintenance of equipment and systems, using provided operation and maintenance data as the basis for instruction.

Part 2 Products

2.1 MATERIALS GENERAL

- .1 All materials, equipment, devices, components, wire and cable shall be CSA approved and listed with ULC as required by code authorities.
- .2 All equipment and components shall be the manufacturer's most current model.

2.2 WIRING

- .1 All wiring for systems to be PVC insulated, shielded, twisted pair, multi-conductor or coaxial, as called for or as required. All wiring shall utilize the pathways for the structured cabling system.
- .2 Cable used shall support RS232 communication and when complete, must perform to complete satisfaction of Consultant and must be free of all interference from cross-talk, hum, switch and relay noise, etc. All wiring to be neatly installed, laced and tagged.
- .3 Cable used shall be as recommended by the manufacturer. All cable to be labeled at both ends with permanently marked labels.

2.3 CLOCK DEVICES

- .1 Clocks shall be round with sweep seconds hand, 317.5 mm [12.5"] in diameter, surface mounted, 24-hour type with Arabic numerals 1:00 – 12:00 to be black and 13 to 24 to be red and come with batteries.
- .2 Clocks to have polycarbonate frame and polycarbonate lens. The clocks face to be white. The hour and minute hands to be black.
- .3 Clocks shall be wall mounted or ceiling mounted as indicated on the drawings and as specified herein.
- .4 Single sided clocks shall be wall mounted as shown on drawings and shall be mounted in accordance to manufacturers mounting standard. Single sided clock with mounting bracket to be equal to Primex item #14155 with custom BCIT logo on the clock face.
- .5 Provide 2 lithium alkaline D-cell batteries with each clock. Batteries to support clock operation for a minimum of 5 years.
- .6 Install clocks at indicated locations on drawings and mount securely to the wall or ceiling. Refer to mounting details provided by supplier.
- .7 Provide tamper-proof/theft resistant hangers for each clock to prevent theft.
- .8 Each clock shall check master transmitter time signal against its own time a minimum of once every four hours to ensure clock time is accurate. Where clock time differs from GPS signal, clock to automatically correct to appropriate time.

2.4 MASTER/SATELLITE TRANSMITTER

- .1 Primex XR Series 1W Transmitter with wall mounted shelf or approved equal.

2.5 GPS RECEIVER

- .1 GPS unit shall be installed on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves and debris. Seal cable connection to GPS with cable connection sealant. Any additional cable length shall be protected from outside elements.
- .2 Primex GPS weatherproof receiver or approved equal.
- .3 Provide Primex Wireless 100 ft (30.5m) extension cable.

2.6 WIRELESS RECEIVER SWITCH

- .1 Primex or approved equal.

2.7 STANDARD OF ACCEPTANCE

- .1 Primex Wireless to match existing or approved equal.

Part 3 EXECUTION

3.1 INSTALLATION

- .1 Install clocks as indicated on the drawings and specified herein.
- .2 Observe clocks until signal is received and clocks adjust to correct time.

3.2 PERFORMANCE

- .1 All equipment shall be installed, connected and configured according to the Manufacturer's recommendations.

3.3 TESTS, ADJUSTMENTS AND OWNERS DEMONSTRATION

- .1 System tests and adjustments to be conducted by the system installer upon completion installation to determine conformance to the requirements of the specification. Tests to be completed prior to the systems demonstration to the Owner.
- .2 Electrical Division to allow for all the time involvement in coordinating and carrying out of all tests and the Owners demonstration.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts

1.2 SCOPE

- .1 This section describes the Operation and Maintenance Data required for project completion.
- .2 This section shall be read together with the sections describing specific systems, components and the manufacture, installation, operation and maintenance thereof.
- .3 Where a discrepancy is noted between the various sections, notify the consultant for an interpretation. In the absence of written clarification, the consultant will assume that the most expensive solution is applicable for use on the projects.

1.3 MANUAL FORMAT

- .1 Upon final inspection, three hard copy Operation and Maintenance manuals sets shall be provided to the Owner. They shall be assembled in 8 ½ x 11 inch capacity, expanding spine catalogue binders. Contractor to provide sufficient quantity to allow all binders to hold system data while in full closed position (not expanded).
- .2 In addition to the specified hardcopies, provide one electronic copy in PDF format.
- .3 Operation and Maintenance manuals to be reproducible by Owner as required.
- .4 Electronic copy to consist of a single Adobe Acrobat PDF divided into chapters to allow a quick and easy access to the different sections of the manual.

1.4 MANUAL CONTENTS

- .1 Operational Guide to include:
 - .1 A complete system description of each system
 - .2 Applicable safety precautions or warnings
 - .3 General Operation instructions for all functions in all rooms and combinations of rooms.
- .2 Maintenance Guide to include:
 - .1 security information
 - .2 cleaning instructions for equipment
 - .3 Light duty maintenance troubleshooting guide
 - .4 Manufacturer supplied maintenance documentation including parts lists, precautionary information, maintenance procedures and warranty information.
- .3 Wiring Table with source, destination, content, wire type and label number of as built system
- .4 Training list of names, signatures and dates of Owner representatives.

- .5 Completed Commissioning Checklists
 - .6 Program data from programmable devices and equipment including all control system data. Contractor shall provide electronic copies of all control processor programming source code which shall become property of the Owner upon system final commissioning. Source code shall not be locked or restricted in any manner after the warranty period.
 - .7 IP addressing scheme information, and firmware version data for installed hardware.
 - .8 Contractor Installation Warranty, contractor contact names, email addresses and telephone numbers for additional equipment, equipment repairs or warranty issues.
 - .9 AS BUILT DRAWINGS
 - .1 Plan of device location
 - .2 Detailed project schematics
 - .3 Wire numbers on drawings to match Wire Table in manual
 - .4 Riser
 - .5 Rack Layout
 - .6 Equipment and control panel elevations
 - .7 Terminal block detail
 - .8 Custom construction or mounting detail
- 2 Products**
- 2.1 SECTION NOT USED**
- 3 Execution**
- 3.1 SECTION NOT USED**

END OF SECTION

1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
 - .1 Section 27 05 00 – Common Works for Communications Systems
 - .2 Section 28 23 00 – Video Surveillance

1.2 SCOPE

- .1 The Contractor shall provide and install an JOHNSON CONTROLS Symmetry ACS system for the Facility connected to the Owner's existing enterprise server. Final connection between the new Facility and the existing enterprise server to be done by the Owner's current vendor.
- .2 The contractor shall provide licences for all electronic safety and security devices included under their scope; such licenses will be applied by the BCIT Security System vendor of record. The contractor shall coordinate with the Owner and handover the licences details for application.
- .3 Provide a new access control system that incorporates control panel(s), contactless smart card reader(s) with LED and keypad, door contact, glass break detectors, motion detectors, strobes lights with all associated mechanical and electric hardware and field devices, including power supplies for a fully operational system.
- .4 The ACS will utilize industry proven devices for intrusion alarm detection and reporting capable of 24 hours per day, seven days per week continuous operation., with 4-hour minimum battery backup operation in the event of power outages.
- .5 The Contractor shall provide all required licenses for fully functional system.

1.3 SHOP DRAWINGS

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

1.4 AS-BUILT DOCUMENTATION

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

1.5 TRAINING

- .1 Train Owner staff (minimum 8 hours) on the use and operation of security systems and location of all security devices.
- .2 Consult and schedule training with the Owner.

1.6 WARRANTY

- .1 System warranty to cover one-year parts and labour from date of substantial performance. Manufacturer's extended warranties on equipment shall apply if typically longer than one year.
- .2 System supplier to include a guarantee that service will be provided on the system within 24 hours of call origination during the warranty period.

- .3 During the warranty period the system installer at his expense will repair and replace all such defective work and other work to the new system, which fails or becomes defective during the term of warranty, provided that such failure is not caused by improper usage or physical dJohnson Controls e.
- .4 Warranty date to commence from date of Final Acceptance of this work.

1.7 GENERAL REQUIREMENTS

- .1 Systems shall be complete with all necessary components to provide functions required whether or not each and every item is necessarily mentioned. All components to be production proven models. Custom designed units will only be considered for those items that are not currently commercially available.
- .2 Selection of system shall be made on the basis of quality and suitability of equipment, service facilities available, experience, capabilities, and past performance of the contracting firm.
- .3 Before proceeding with installation, successful system installer to submit shop drawings per 27 05 00.

1.8 CONTRACTOR QUALIFICATIONS

- .1 The Contractor shall provide valid JOHNSON CONTROLS certification (certification number and expiry date) as proof they are certified to purchase, install, and warranty all JOHNSON CONTROLS hardware.
- .2 Contractor shall be based in Yukon and available for 24/7 support as pertaining to JOHNSON CONTROLS hardware.

2 Products

2.1 ACCESS CONTROL SYSTEM (ACS)

- .1 The ACS shall be interconnected to the electrified locks to lock and unlock doors via time schedule and card readers utilizing proximity field effect technology and/or pin code. The ACS shall grant or restrict access to staff and students on a door by door basis via a programmable classification system and shall operate over the Owner's network.
- .2 The ACS shall have the capability to lock down areas identified by the Owner in the event of an emergency or global command.
- .3 The ACS shall function at the field controller level without connection to the PC host or gateway. All electrified locks shall be hard wired to the field control panels. The field controllers shall be located in Communications Rooms (see Division 27) and shall be connected to the access control server via TCP/IP using the structured cabling.
- .4 The ACS shall use hard-wired proximity type readers with LCD and keypad and shall be capable of reusing all existing cards presently distributed across the BCIT. Existing cards are **MIFARE DESFire EV1**. The ACS shall be compatible with the Owner's existing systems to allow existing Owner cards to work on the system and allow new cards for the Facility to work on systems in the rest of the Owner's regions.
- .5 The ACS shall be complete with mapping and shall be implemented to match the existing format in use. The maps shall include interactive alarm points for all

(access doors, intrusion detection, video surveillance cameras and panic/duress stations).

- .6 All security alarms will be logged for a minimum period of one (1) year. Logging system will be capable of external archiving/backup on external storage.
- .7 Security recording will provide, as a minimum, the following information for each alarm:
 - .1 Date;
 - .2 Time;
 - .3 Device identification;
 - .4 Descriptive code;
 - .5 User/cardholder ID (when applicable); and
 - .6 Acknowledgement and action taken (when applicable).

2.2 SERVER HARDWARE

- .1 The ACS shall utilize the Owner's existing file server and allow multiple workstations to access the file server for control and annunciation purposes.

2.3 DATABASE

- .1 The Contractor will ensure the new ACS utilizes the existing database of users, groups and schedules such that any change to one system will affect and cause the same change on the other system with no additional input or action.

2.4 WORKSTATION

- .1 Access control workstation(s) are not required.

2.5 SYSTEM CONTROLLER

- .1 The Database Unit with Integrated Door Controller (DBC) shall link the ACS Software to all "down-stream" field hardware. The DBC shall provide full distributed processing of access control / Alarm Monitoring rules and operations. A fully loaded and configured ISC with shall respond in less than one-half (0.5) second to grant or deny access to cardholder.
- .2 The DBC shall continue to function normally (stand-alone) in the event that it loses communication with the ACS software. While in this off-line state, the DBC shall make access granted/denied decisions and maintain a log of the events that have occurred. Events shall be stored in local memory, and then uploaded automatically to the ACS database after communication has been restored.
- .3 The DBC shall be capable of supporting 20,000 cardholders (expendable to 250,000). Any DBC that serves areas deemed as common areas shall be coupled with the required plug-in memory module to support 250,000 cardholders. Common areas include:
 - .1 Building entrances
 - .2 Meeting and student study/project rooms
 - .3 Active learning and debrief spaces
 - .4 Multipurpose classrooms

- .5 Other areas as required by the owner
- .4 The DBC shall be capable of supporting up to 16 card readers with the addition of optional door controllers.
- .5 The DBC shall includes integrated RS232 port.
- .6 The DBC to be provided with network interface module allowing LAN or wireless access.
- .7 Part Number(s):
 - .1 JOHNSON CONTROLS M2150-8DBC
- 2.6 DOOR CONTROLLER(S) (DC)**
 - .1 The door controller shall extend DBC to support up to 16 readers.
 - .2 Part Number(s):
 - .1 JOHNSON CONTROLS M2150-4DC, JOHNSON CONTROLS M2150-8DC
- 2.7 NETWORK INTERFACE MODULE(S) (NIC)**
 - .1 Plug-in module shall connect to the DBC to provide IP network interface connection.
 - .2 Part Number(s):
 - .1 JOHNSON CONTROLS MN-NIC-4-ENC
- 2.8 DATABASE UNIT WITH INTEGRATED ELEVATOR INTERFACE**
 - .1 Each elevator controller shall support 20,000 cardholders (expandable to 250,000) and up to 64 floors. Includes enclosure and power-supply.
 - .2 Part Number(s):
 - .1 JOHNSON CONTROLS M2150-ELEV-S, JOHNSON CONTROLS M2150-ELEV-EXT-S
- 2.9 INPUT AND OUTPUT MODULE(S)**
 - .1 Plug-in input and output module(s) shall mount onto the DBC and DC to provide additional inputs and outputs.
 - .2 Part Number(s):
 - .1 JOHNSON CONTROLS M2150-AC8/4
- 2.10 INPUT AND OUTPUT CONTROLLER(S)**
 - .1 Input and output controllers shall connect to DBC via RS485 to provide additional I/O.
 - .2 Part Number(s):
 - .1 JOHNSON CONTROLS M2150-AC24/4, M2150-OC4/24
- 2.11 COMBINATION PIN CODE/PROXIMITY READER**
 - .1 The Contractor will provide combination pin code/proximity card readers at all required access/egress locations to/from all controlled areas as indicated on drawings.

- .2 Combination pin code/proximity card readers shall be fully integrated into the Building's access control platform. Combination pin code/proximity card readers shall facilitate access by the following methods:
 - .1 Pin code only;
 - .2 Card read only and
 - .3 Pin code and card read.
- .3 Key Features of the pin code/proximity card reader shall be:
 - .1 Read both NXP MIFARE and MIFARE DESFire EV1 and EV2 smart cards
 - .2 Maximum range of up to 50mm
 - .3 Audible feedback
 - .4 LED for verification of card accepted and card rejected
- .4 Part Number(s):
 - .1 JOHNSON CONTROLS S849-KP-AG

2.12 DOOR CONTACT

- .1 By Division 8.

2.13 POWER SUPPLIE(S) AND ENCLOSURE(S)

- .1 Power supplies shall be on a dedicated emergency circuit and centralized within the Communications Rooms. All access control and door hardware components shall be powered via individually fused outputs from the power supplies.
- .2 Individual power supply shall not serve more than sixteen (16) doors, or multiple floors in the Building.
- .3 Part Number(s):
 - .1 LifeSafety Power – FPO150/250-2C82D8E8A

2.14 PROXIMITY CARDS

- .1 The Owner will provide proximity cards for Yukon University staff and students (MIFARE DESFire EV1).

2.15 GLASSBREAK DETECTORS

- .1 Part Number(s):
 - .1 Honeywell FG-730 or approved equal

2.16 MOTION DETECTORS

- .1 Part Number(s):
 - .1 Bosch DS936, Bosch ISC-BPR2-W12 or approved equal

2.17 PANIC BUTTONS

- .1 Panic buttons shall have a yellow shell, indoor/outdoor rated flush cover, Turn-to-Reset illuminated green mushroom style push button.
- .2 Contractor to verify custom text on the panic button shell and cover with the

Consultant and the Owner before ordering.

.3 Part Number(s):

.1 STI SS2239ZA-EN or approved equal

2.18 BLUE STROBE LIGHTS WITH INTEGRATED HORN

.1 Strobe lights shall be provided at each panic button location.

.2 Strobe light's lens colour shall be blue.

.3 Part Number(s):

.1 STI-SA5000-B or approved equal

2.19 WIRE AND CABLE(S)

.1 Part Number(s):

.1 Noramco or approved equal

3 Execution

3.1 PROGRAMMING

.1 The Owner's current vendor will be responsible for assigning access and programming schedules.

.2 The contractor shall coordinate with the Owner's current vendor to facilitate programming of the new hardware devices into the software.

3.2 INTEGRATIONS

.1 The use of system integration points within the Access Control System is not permitted.

.2 The access control system shall be interconnected to the elevator controls for floor by floor access control via card reader in elevator 1. Card reader in cab shall be flush mounted to the car operating panel.

.3 Interconnect the access control system to the fire alarm system to release doors in the event of a fire as required by applicable Laws and or standards.

.4 Provide interconnection of the ACS to other security systems as required.

3.3 INSTALLATION

.1 Conduit must be used for security cabling within the secured space. Cable tray may be utilized to run security wiring outside of secured spaces.

.2 All security control panels shall be located in secure, accessible location within the protected space (i.e. – panels and equipment shall not be mounted in electrical or data rooms that are not within the protected space).

.3 All cable and equipment supplied, and all installation methods used, shall be as specified by the equipment manufacturer.

.4 No splices shall be permitted in the wiring except where a connection is made to a device.

.5 Electrical panel circuit number shall be clearly identified on all system panels.

3.4 LABELING

- .1 All equipment units (field panels, access control units, etc.) to have lamicoid description label. Description to be in code as directed by the Contractor.
- .2 All wire and cable to be labeled with suitable identification code affixed to cable jacket near terminations. Label to be permanently affixed, vinyl, plastic or similar material.

END OF SECTION

1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts, including:
 - .1 Section 26 05 00 – Common Works for Communications Systems
 - .2 Section 27 05 26 – Pathways for Communications Systems
 - .3 Section 27 15 00 – Horizontal Cabling
 - .4 Section 28 16 00 – Security and Access Control Systems

1.2 SCOPE

- .1 The Contractor shall provide and install a video surveillance system, including but not limited to all cameras, equipment, hardware and licensing required for a fully functional system, throughout and around the Facility, for the purposes site security. The video surveillance system will connect to the Owner's existing Genetic DVMS. Final connection between the new Facility and the existing enterprise server, and adjustment of field of view, to be done by the Owner's currently contracted vendor.
- .2 The contractor shall provide licences for all CCTV devices included under their scope; such licenses will be applied by Yukon University Security System vendor on record. This includes camera licences on the Owner's current Genetic server. The contractor shall coordinate with the Owner's currently contracted vendor to handover the licences details for application.
- .3 The existing management server and recording and archive servers will be used to support the additional storage and bandwidth for all new devices.
- .4 Provide and install all power, control, and video conduit, and cabling for the CCTV system.
- .5 CCTV cameras are to be provided in locations as shown on the drawings.
- .6 All camera locations shown on the drawings are subject to change. These locations may change by up to 5m from those locations shown on the drawings due to site conditions.
- .7 Yukon University signage shall be provided where routine surveillance is conducted, advising that the space is under electronic surveillance.

1.3 SHOP DRAWINGS

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

1.4 AS-BUILT DOCUMENTATION

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

2 Products

2.1 DVMS SERVER HARDWARE

2.2 CAMERAS - GENERAL

- .1 All indoor and outdoor cameras shall have vandal -resistant housings with tamper, capable of being surface or flush mount according to the surface it's being mounted to.
- .2 Indoor cameras shall be dome cameras, colour, IP, PoE 802.3af with a minimum resolution of 1920x1080, and shall be capable of recording in H.264.
- .3 Cameras within the Building viewing outside entrances through glass windows or doors shall have a wide dynamic range image setting.
- .4 Outdoor cameras shall be colour, IP, PoE 802.3af with a minimum resolution of 1920x1080 and capable of recording in H.264 format.
- .5 The outdoor cameras shall have a day night cut filter and be able to operate in temperatures ranging from -40° to 50°
- .6 Outdoor cameras shall be complete with weatherproof housing and internal heater/blower/wiper as required for suitable operation under varying environmental conditions. Provide hood extensions and shields where required to prevent picture degradation due to direct sunlight or lamp glare.
- .7 Outdoor camera brackets and hardware shall be furnished with weather resistant coatings preventing corrosion and staining. The housings shall be capable of mounting on poles parapets and walls.
- .8 Pan-tilt-zoom (PTZ) cameras shall be color, IP, PoE, with a minimum resolution of 1080p, capable of minimum 30x optical zoom, high-speed with low light day/night operation capability with 360 degrees rotation in less than 3 seconds. Domes will mount on poles, parapets and walls located to provide optimum unobstructed viewing of the area under surveillance. PTZ cameras will have the ability to mask portions of view through software and remote programming.

2.3 INDOOR FIXED DOME IP CAMERAS

- .1 Single lens camera part number(s):
 - .1 2MP indoor camera: Axis P3225-V MK II or approved equal.
 - .2 5MP indoor camera: Axis P3227-LV or approved equal.
- .2 Multi lens camera part number(s):
 - .1 8MP 4-lens camera: Axis P3717-PLE or approved equal.
 - .2 20MP 4-lens camera: Axis P3719-PLE or approved equal.
 - .3 15MP 3-lens camera: Axis Q3708-PVE or approved equal.

2.4 INDOOR PTZ IP CAMERAS

- .1 Part number(s):
 - .1 Axis P5635-E MK II or approved equal.

2.5 LICENSE PLATE RECOGNITION CAMERAS

- .1 Part number(s):
 - .1 Axis Q1786 or approved equal.

2.6 OUTDOOR PTZ IP CAMERAS

- .1 Part number(s):
 - .1 8MP Axis Q6128-E PTZ or approved equal.

2.7 CABLE

- .1 At a minimum, Category 6A UTP cable shall be run to each camera. All wire runs shall be a continuous home run back to the head end or closet Communications Room as per section 7.9.5 Structured Cabling specifications. Where runs exceed 90m, and only with approval from the Owner, provide media converters complete with power source and fibre optic cable to ensure TIA/EIA compliance; if media converters are located outdoors, they must be provided in a weatherproof housing. Contractor must receive approval from the Owner prior to utilizing media converters.
- .2 Where fibre optic cable is required, fibre connectors shall be TIA compliant and rated for indoor and outdoor use. Installation of fibre optic cabling to outdoor applications shall be done so that the weatherproofing characteristics of the cabling are not compromised;

2.8 LABELLING AND CONNECTORS

- .1 Refer to Section 27 15 00 – Horizontal Cabling

2.9 NETWORKING EQUIPMENT

- .1 Switches
 - .1 Provided by the Owner.

2.10 WORKSTATION

- .1 CCTV workstation(s): are not required.

3 Execution

3.1 PERFORMANCE

- .1 All equipment shall be installed and configured according to the Manufacturer's recommendations.

3.2 PROGRAMMING

- .1 The Owner's currently contracted vendor shall be responsible for programming all systems.

3.3 INSTALLATION

- .1 Co-ordinate phasing of work with other trades.
- .2 CCTV system Cat 6A UTP cabling shall be installed to meet specification section 27 15 00.
- .3 All wiring shall be concealed unless otherwise authorized by the Consultant.
- .4 All CCTV system equipment shall be located in secure communication rooms.

- .5 All cable and equipment supplied, and all installation methods used, shall be as specified by the equipment manufacturer.
- .6 Electrical panel circuit number shall be clearly identified on all system panels.
- .7 Dress cables neatly into equipment rack
- .8 All work shall be installed in a neat and workmanlike manner. The contractor is responsible for clean up and disposal of all garbage and debris caused as a result of their work.
- .9 Confirm all camera mounting locations with Consultant and Owner. Provide mounting detail and hardware at each location with shop drawings.
- .10 Provide any required additional backing or structural support required for camera mounting.

3.4 ASSET MANAGEMENT

- .1 Physically tag the following devices as required for data entry into the electronic security asset management system owned and operated by the Owner:
 - .1 Camera bodies;
- .2 Asset tags to be provided by the Owner; data entry to be provided by the Owner.
- .3 Provide individual asset information, as required, to facilitate asset management database requirements.

END OF SECTION

1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts, including:
 - .1 Section 27 05 00 – Common Works for Communications Systems
 - .2 Section 28 16 00 – Intrusion Detection
 - .3 Section 28 23 00 – Video Surveillance System

1.2 SCOPE

- .1 The Contractor will provide an integrated, fixed, SIP VoIP Emergency Phone System(s) to initiate emergency assistance calls in the parkade level and building exterior at the locations indicated on the drawing.
- .2 The Contractor will provide fixed, hard wired, push button Panic/Duress Stations for staff and or public in designated areas. These buttons will be monitored by the Access Control System and will trigger an alarm via the existing AMAG/Symmetry software. Final connection to the existing system shall be done of the Owner’s currently contracted vendor.
- .3 System shall include alerting and reporting functionality capable of showing time and location for all incidents.

1.3 SHOP DRAWINGS

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

1.4 AS-BUILT DOCUMENTATION

- .1 To be furnished as specified in Specification Section 27 05 00 Common Works for Communications Systems.

2 Products

2.1 EMERGENCY PHONE STATIONS

- .1 Approved manufacturer: Code Blue as follows, graphics and configuration to be determined in consultation with the Owner:
 - .1 Model CB1-s with overhead camera mount to match existing site for all exterior areas
 - .2 Model CB2-e for all interior parking areas

2.2 FIXED PANIC/DURESS STATIONS

- .1 All fixed Panic/Duress Stations shall be hard wired, supervised for faults, strategically located, suitably sized, suitable for its environment and clearly labelled for “security emergency only”.
- .2 Panic/Duress Stations in areas intended for public safety use shall be wall mounted and located as indicated on drawings. The fixed Panic/Duress Stations shall have an illuminated mushroom style twist lock push button that will change its state of color when activated and will then resume back to its stand by color when reset. Color states to be confirmed in consultation with the Owner.
- .3 Affixed wireless buttons are not acceptable; fixed buttons are to be hard wired.

.4 Clear protective/anti tamper covers are required

.5 Part Number(s): STI SS2239ZA-EN

2.3 WORKSTATIONS AND DISPLAYS

.1 Workstations are not required.

2.4 ALARM NOTIFICATION AND ENUNCIATION

.1 Local visual display devices (enunciators) will be required for alarm notification.

.2 Local department, floor and building alarm notification and alert methods include:

.1 Visual enunciation at each individual panic/duress station

.2 Part Numbers(s): STI-SA5000-B

.3 Emergency phone stations shall be coupled with a built-in beacon/strobe.

3 Execution

3.1 PERFORMANCE

.1 All equipment shall be installed and configured according to the Manufacturer's requirements.

3.2 PROGRAMMING

.1 All programming associated with the hardwired Panic/Duress System(s) shall be by the Contractor.

.2 System programming is to be completed to the satisfaction of the Owner.

3.3 INSTALLATION

.1 Co-ordinate phasing of work with other trades.

.2 All cable and equipment supplied, and all installation methods used, shall be as specified by the equipment manufacturer.

.3 All wiring shall be concealed unless otherwise authorized by the Consultant.

.4 All cables shall be permanently identified and listed on as-built drawings as follows:

.1 Cable number

.2 Source

.3 Destination

.5 Electrical panel circuit number shall be clearly identified on all system panels.

.6 All cables to be labeled at both ends with termination location.

3.4 MONITORING

.1 The Panic/Duress System will report the alarm location to the Security Communications Centre via monitoring software. Final connection to the existing system shall be done by the Owner's currently contracted vendor.

3.5 ASSET MANAGEMENT

- .1 Physically tag the following devices as required for data entry into the asset management system owned and operated by the Authority:
 - .1 Panels;
 - .2 Fixed buttons;
 - .3 Connected network equipment.
- .2 Asset tags to be provided by the Owner; data entry to be provided by the Owner.
- .3 Provide individual asset information, as required, to facilitate asset management database requirements.

END OF SECTION

Part 1 General

1.1 Related Work

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts. This document to be read in conjunction with the electrical, mechanical drawings, and Code Report and code drawings.

1.2 Waste Management and Disposal

- .1 Separate and recycle waste materials in accordance with Division 01 – Waste Managing and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal packaging material for recycling in accordance with Division 01 – Waste Managing and Disposal.

1.3 Regulatory Requirements

- .1 The fire alarm system to be designed and installed to meet the following standards:
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 and bulletins & amendments for British Columbia.
 - .2 National Building Code latest edition
 - .3 CAN/ULC S524-14 with amendments: Standard for Installation of Fire Alarm System.
 - .4 CSA-B44-07. Safety Code for Elevators & Escalators.
- .2 Installation subject to approval of consultant and fire marshal for final acceptance.

1.4 Standard of Acceptance

- .1 Acceptable Manufacturer:
 - .1 Simplex 4100ES

1.5 SCOPE

- .1 Provide all labour, material, and equipment necessary for a single stage fire alarm system.
- .2 Include all wiring and material required to complete the installation. Items obviously necessary or reasonably implied to complete the work are to be supplied as if indicated on the drawings and called for in the specifications.
- .3 Work Included:
 - .1 Provide new fire alarm system, one stage, addressable detectors, ancillary relays, and signaling devices as indicated on the drawing
 - .2 Provide tamper and flow switches as indicated on the drawings. Coordinate with the fire protection drawings for exact number and location.
 - .3 Provide monitoring of all tamper and flow switches at the fire alarm annunciator.
 - .4 The fire alarm system shall be interconnected and feed back to the campus fire alarm monitoring station in Building SE08 via copper and fibre optic cabling.
 - .5 Perform all the required programming, verification & documentation as shown and described here in.
 - .6 Div. 26 shall coordinate with mechanical drawings and Fire Protection drawings.

1.6 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for fire alarm systems.
 - .2 Control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating single-stage alarm, supervising system continuously, actuating zone annunciators, and initiating trouble signals.
 - .3 Trouble signal devices.
 - .4 Power supply facilities.
 - .5 Manual alarm stations.
 - .6 Automatic alarm initiating devices.
 - .7 Audible signal devices.
 - .8 End-of-line devices.
 - .9 Annunciators.
 - .10 Visual alarm signal devices.
 - .11 Ancillary devices.

1.7 Shop Drawings and Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 05 00 – Common Work Results for Electrical and as outlined herein. All shop drawings items to be within one complete submission.
- .2 Shop drawings to include a complete material list with manufacturer, style, model number, and quantity. Provide battery information and ampere\hour sizing calculation based on the actual equipment load. Include the calculated load in the various system operation modes.
- .3 Shop Drawings
 - .1 Submit shop drawings of fire alarm devices as applicable:
 - 1. F/A CCU
 - 2. F/A signalling devices
 - 3. F/A graphic annunciator, Staff station LED fire alarm annunciator
 - 4. Manual & automatic detection devices
 - 5. Door Holders
 - 6. Any related F/A equipment not included in this list.
 - 7. Heat trace monitor.
 - 8. Fire alarm system riser diagram, include all floors.
 - 9. VESDA system: shop drawings of the system, calculation on the sampling point location requirements, layout of the sampling point location.
- .4 Shop drawings to include manufacturer's specification sheets with photographic depiction of all system components. Specification and descriptive data to include dimension, weight, appearance, connection provisions, materials, metal gauges and operating specification, characteristics, features and controls.

- .5 Shop drawings to include the following diagrams:
 - .1 Detail assembly and internal wiring diagrams for control unit.
 - .2 Overall system riser and wiring diagram identifying control equipment initiating zones signaling circuits; identifying terminations, terminal numbers, conductors and raceways.
 - .3 Details for devices.
 - .4 Details and performance specifications for control, annunciation, and peripherals with item by item cross reference to specification for compliance.
 - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.
 - .6 Battery capacity calculations.
 - .7 Manufacturer recommended testing material, devices, equipment and methods for smoke and heat detectors.
 - .8 Shop drawings to be stamped by manufacturer to ensure equipment/design is in accordance with ULC standards
 - .9 Complete wiring diagram showing terminal identification, cable type and cable designation.
- .6 No material or equipment to be delivered to the jobsite prior to final review of shop drawings unless otherwise specified and documented in writing by the Consultant.
- .7 Provide factory data sheets for the following:
 - .1 Main panel, annunciator panels, and control units, indicating:
 - .2 All materials,
 - .3 Finishes,
 - .4 Layouts,
 - .5 Proposed labelling.
- .8 Riser diagrams and detail drawings to be prepared in AutoCAD to professional standards. Provide hard copies with the shop drawing submittals.
- .8 Include:
 - .1 Layout of equipment.
 - .2 Zoning.
 - .3 Complete wiring diagram, including schematics of modules.

1.8 Warranty/Service

- .1 System installer to include with his base tender price a guarantee stating:
 - .1 Service to be provided on system within 24 hours of call origination during the warranty period.
 - .2 Full warranty on new system to be provided for a period of 12 months.
 - .3 During warranty period the system installer at his expense shall repair and replace all such defective work and other work to the new system damaged thereby which fails or becomes defective during the term of the warranty, provided that such failure is not caused by improper usage, or physical damage.
 - .4 Warranty date to commence from date of final acceptance of this work.

1.9 Training

- .1 The Fire Alarm system supplier to conduct "Factory Level" training programs for designated maintenance and operating personnel. Training to be carried out at the project site. Program to include but not be limited to the following:
 - .1 Operation: designated personnel to be trained to accomplish and understand all aspects of system operation.
 - .2 Maintenance: designated personnel to be trained to perform routine maintenance on the system.
- .2 Training period schedule to be confirmed with the Consultant. Training periods to take place after the system final verification.
- .3 Allow for two separate all day training seminars/workshops for a maximum of 5 people.
- .4 Provide a formal training agenda and issue certificates to attendees upon completion.
- .5 Provide maintenance manuals and record drawings as part of training materials.

1.10 Tests and Adjustments

- .1 Upon completion of system installation, tests to be conducted by the system installer to determine system conformity to requirements of the specification. Tests to be conducted in presence of the Owners representative and Consultant who may suspend or discontinue tests at any time performance is considered unsatisfactory. Resumption of testing to cover the previously untested elements and any completed elements at the discretion of the Consultant.
- .2 All equipment or wiring provided by system installer which tests prove to be defective or operating improperly to be corrected or replaced promptly at no additional cost to the Owner.

1.11 System Supervision

- .1 Initiation device riser loop wiring to be Class A to isolators located in a minimum 1-hour rated enclosure on each floor. Class A conduit spacing to be to ULC S524 or as indicated.
- .2 Fire alarm manual stations, detectors, sprinkler (fire protection) circuits from initiation loop riser may be Class B on each floor area as indicated.
- .3 Complete system to be supervised against failure of operating power, open circuits, and ground. Supervision to be maintained on all circuits even in the event of a power failure, when the system is on battery standby.
- .4 System to incorporate a silencing switch in the main control panel and at the fire command centre, which when operated, silences the trouble bell but causes the trouble lamp to remain illuminated until the trouble is cleared and the system returned to normal. Upon return to normal, trouble signal lamp shall be automatically reset to normal.

1.12 System Operation

- .1 Fire alarm system shall be a single stage, fire alarm voice communication, addressable system.
- .2 Operation of any fire alarm signal initiating device shall automatically perform the following functions:
 - .1 Provide visual indication at the fire alarm annunciator panel and fire alarm control panel of fire condition and location.
 - .2 Provide alarm and trouble signal transmission to the central monitoring station in BCIT Building SE08.

- .3 Disconnect power supply to electromagnetic door holders associated with smoke control doors (on a zoned and adjacent zone basis).
- .4 Activate audible signals to sound a temporal pattern.
- .5 Visual alarm devices shall activate at a rate no faster than 120 flashes per minute and stop flashing once the fire alarm control panel has been silenced. Where more than one visual device is visible from a single location, visual device flash rate shall be synchronized.
- .6 Provide fan start or shut down for mechanical supply and return fans in accordance with the schedule.
- .7 Activate elevator controls and invoke homing on activation on detection of smoke in the elevator lobby, elevator shaft, or associated machine room.
- .8 If the smoke detector is activated on the main elevator homing floor, the elevator shall home to the alternate floor.
- .9 Start pressurization fans as indicated on the drawings.
- .10 Provide visual indication at all LCD annunciators.
- .11 Release all electromagnetic locks (e.g. security locks) and any electrically held security doors and panic hardware on all doors within routes of egress.

1.13 Coordination

- .1 Coordinate installation of fire alarm system with:
 - .1 Mechanical equipment controls.
 - .2 New Sprinkler system flow and gate valve installation.
 - .3 Generator controls.
 - .4 Building Management system.
 - .5 Other related work such as door hardware.
- .2 Coordinate with the above noted work as required to provide a complete, integrated, functional system.

1.14 Labelling – Devices and Pullboxes

- .1 Provide a 'Brother' style commercial quality label on each fire alarm device. Label to be clearly visible from the ground and contain the device address information.
- .2 Provide a red lamicaid label on all fire alarm equipment boxes such as isolators, relays, terminal blocks etc. and wiring pull boxes. Lamicaid to be a minimum size 25mm x 50mm with clear white lettering indicating function, circuit address etc.

1.15 System Maintenance and Testing Facility

- .1 Provide required hardware/software such that ancillary, signal and monitoring station systems can be temporarily disabled by site personnel to enable testing of system. A trouble signal shall be present during testing but system ULC approval will be unaffected.

Part 2 Products

2.1 MATERIALS

- .1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .2 Power supply: to CAN/ULC-S524.
- .3 Audible signal devices: to CAN/ULC-S525.

- .4 Visual signal devices: to CAN/ULC-S526.
- .5 Control unit: to CAN/ULC-S527.
- .6 Manual pull stations: to CAN/ULC-S528.
- .7 Thermal detectors: to CAN/ULC-S530.
- .8 Smoke detectors: to CAN/ULC-S529.

2.2 SYSTEM OPERATION

- .1 Provide complete, electrically supervised, fire alarm system.
- .2 Provide separate circuits from control panel to each zone of initiating devices. Transmission of signals from more than one zone over common circuit to control panel is prohibited.
- .3 Fire alarm system shall be remotely monitored by a ULC listed monitoring station, as required by the building code.
- .4 The fire alarm system shall be zoned by floors. The fire alarm zoning and sprinkler system zoning shall be consistent with the fire alarm system operation sequence. The fire alarm annunciator shall have separate zone indication for the actuation of smoke detectors, heat detectors, manual stations, and waterflow detecting devices.
- .5 Single stage operation. Operation to actuation following:
 - .1 Manual station.
 - .2 Heat detector.
 - .3 Smoke detector.
 - .4 Automatic fire sprinkler system.
 - .5 Fire extinguishing system.
 - .6 Fire standpipe system.
- .6 Actuation of single operation device to initiate following:
 - .1 Building evacuation alarm devices to operate continuously.
 - .2 Transmit signal to fire department via monitoring station.
 - .3 Zone of alarm device to be indicated on control panel annunciator.
 - .4 Air conditioning and ventilating fans to shut down or to function so as to provide required control of smoke movement.
 - .5 Fire doors and smoke control doors if normally held open, to close automatically.
 - .6 Electro-magnetic door holders to de-energize.
 - .7 Operations to remain in alarm mode (except alarm notification appliances if manually silenced) until system is manually restored to normal.
- .7 Firefighter Emergency Operation CSA B44-07:
 - .1 Fire Detection Signals:
 - .1 Building Fire Alarm
 - .2 Designated Return Floor Detector
 - .3 Machine Room Detector
 - .4 Top of Hoistway Detector

- .5 Pit Detector
- .2 Provide Firefighters Emergency Operation Signalling Requirements as required by CSA B44-07.

2.3 Addressable Monitor Modules

- .1 Addressable monitor elements to meet or exceed the following technical requirements:
 - .1 Compatible with main fire alarm system.
 - .2 Field programmed.
 - .3 Individually identifiable.
 - .4 Supervised.
 - .5 Supervises and controls N.O. contact devices on supervised slave line. Supervision in Class B format with end-of-line resistor.
 - .6 Operating Voltage: 24 volts.
 - .7 Slave Line Resistance: 50 ohms maximum.
 - .8 Ambient Temperature: 0°C - 40°C.
 - .9 Ambient Humidity: 0 - 93%.
 - .10 Complete with lamicoid identification on cover identifying address and device monitored

2.4 Fire Alarm Control Panel

- .1 Fire alarm Control panel shall be placed in the Electrical Room as indicated on the drawings.
- .2 Single stage operation
- .3 Mount top of panel enclosure at 1.8 m above finished floor elevation.
- .4 Enclosure:
 - .1 CSA Enclosure c/w lockable concealed hinged door, full viewing window, flush lock and 2 keys.
 - .2 Provide modular type panel installed in surface mounted steel cabinet with hinged door and cylinder lock.
 - .3 Switches and other controls: not accessible without use of key.
 - .4 Design of control panel: neat, compact assembly containing parts and equipment required to provide specified operating and supervisory functions of system.
 - .5 Control panel components: CSA approved and approved by control panel manufacturer for use in control panel.
 - .6 Panel cabinet: finished on inside and outside with factory-applied enamel finish.
 - .7 Provide main annunciator located on exterior of cabinet door or visible through cabinet door.
 - .8 Provide audible trouble signal.
 - .9 Provide identification plates, attached to rear face of panel viewing window, for lamps and switches.
 - .10 Provide [1] set of Form C dry alarm contacts per zone, common system Form C dry alarm contact, and common system Form C dry trouble contact.

- .11 Permanently label switches.
- .12 Provide panel with following switches:
 - .1 Trouble silencing switch which silences audible trouble signals including remote trouble devices without extinguishing trouble indicating lamp(s).
 - .1 For non-self-resetting type switch: Upon correction of trouble condition, audible signals will again sound until switch is returned to its normal position.
 - .2 For silencing switch of momentary action self-resetting type: trouble signal circuit automatically restored to normal upon correction of trouble condition.
 - .2 Evacuation alarm silencing switch which when activated will silence alarm notification appliances without resetting panel, and cause operation of system trouble signals. Subsequent alarm(s) from additional zone(s) not originally in alarm to cause activation of notification appliances even with alarm silencing switch in "silenced" position.
 - .3 Individual zone disconnect switches which when operated will disable only their respective initiating circuit and cause operation of system and zone trouble signals.
 - .4 Reset switch which when activated will restore the system to normal standby status after cause of alarm has been corrected, and activated initiating devices reset.
 - .1 Operation of reset switch to restore activated smoke detectors to normal standby status.
 - .5 Lamp test switch.
 - .6 Drill switch which will enable test of notification appliances and restoration to normal without tripping master box.
 - .7 Master box disconnect switch which when activated will disconnect coded device and cause operation of system trouble signal.
 - .8 HVAC shutdown bypass switch. Operation of the switch to allow HVAC system to operate with detectors in alarm and cause operation of system trouble signals.
- .5 Supervised, modular design with plug-in modules:
 - .1 Alarm receiver with trouble and alarm indications, provision for remote supervised annunciation, for class [A] initiating circuit.
 - .2 Spare zones: compatible with smoke detectors and open circuit devices.
 - .3 Space for future modules.
 - .4 Latching type supervisory receiver circuits. Discrete indication for both off-normal and trouble.
- .6 Components:
 - .1 Coded alarm receiver panel with trouble and alarm indications for class A initiating circuit.
 - .2 Single stage alarm pulse rate panels:
 - .1 Single stroke control type for output to signal control panel continuously.

- .3 Common control and power units:
 - .1 Control panel containing following indications and controls:
 - .1 "Power on" LED (green) to monitor primary source of power to system.
 - .2 "Power trouble" indication.
 - .3 "Ground trouble" indication.
 - .4 "Remote annunciator trouble" indication.
 - .5 "System trouble" indication.
 - .6 "System trouble" buzzer and silence switch c/w trouble resound feature.
 - .7 System reset switch.
 - .8 "LED test" switch if applicable.
 - .9 "Alarm silence" switch to silence signals manually. If new alarm occurs after signals have been silenced, signals to resound.
 - .10 "Signals silenced" indication.
 - .2 Master power supply panel to provide 24 V dc to system from 120 V ac, 60 Hz input.
 - .3 Fire department connections:
 - .1 Plug-in module for [tripper] [shunt] type municipal box.
 - .2 Fire department bypass switch c/w indicator for trouble at panel.
 - .4 Auxiliary relays: plug-in type, dust cover, supervised against unauthorized removal by common trouble circuit [and c/w individual bypass switch].
 - .1 Contacts: 2.0 A, 120 V ac, for functions such as release of door holders or initiation of fan shut down.
 - .2 Contact terminal size: capable of accepting 22-12 AWG wire.

2.5 POWER SUPPLY

- .1 120 V, ac, 60 Hz input, 24 V dc output from rectifier to operate alarm and signal circuits, with standby power of gell cell batteries minimum expected life of 4 years, sized in accordance with NBC.

2.6 Main Graphic Annunciator Panel

- .1 Fire Alarm Annunciator shall be installed at the designated entrance, in accordance with the drawings.
- .2 Provide LED indicator light at the annunciator panel for the generator 'running'.
- .3 Provide trouble light at the annunciator panel for monitoring the pressure in the dry sprinkler system - "Low Air Pressure".
- .4 Door to be complete with hinges, lock and keys.
- .5 Graphic to include each floor, floor zones exits, exit corridors, and a "You Are Here" sign, with the proper orientation on the graphic panel.
- .6 Special features:
 - .1 Graphic display panel to have art work to allow for future changes without replacement of total panel.

- .2 LED (lights) are to be site changeable. LED mounting on a modular design and LED sockets to be mounted to a second interior backplate, hinged from backbox.
- .7 Graphic annunciator panel to be complete with lamp test button. Test button to operate all indicators.
- .8 Graphic annunciator panel to be complete with trouble buzzer silence, acknowledge button, alarm silence and system reset.
- .9 Main annunciator to be separated into zones.

2.7 Signal Amplifiers (Audio Power Amplifiers)

- .1 Provide sufficient amplifiers (and power packs) to drive all fire alarm related equipment including speakers and signal devices in the areas covered by each panel at their required rated loads simultaneously. Tap settings of all speakers to be set at a level to meet ULC standards and area conditions.
- .2 Amplifiers to be solid state, either rack mounting type for centralized system or modular type for distributed system associated with individual floor areas and stairways.
- .3 No amplifiers to be loaded beyond 80 percent of its rated capacity.
- .4 Provide backup preamplifiers and amplifiers with rating equal to capacity of rating of the primary (normal use) amplifiers. Upon amplifier failure, standby amplifiers to be switched into operation automatically with trouble annunciation at panels specified.
- .5 Amplifiers to be minimum dual channel type.
- .6 Amplifiers to be ULC approved for fire alarm use and easily replaceable from factory stock.

2.8 Addressable Monitor Modules

- .1 Addressable monitor elements to meet or exceed the following technical requirements:
 - .1 Compatible with main fire alarm system.
 - .2 Supervises normally open contact devices on supervised slave line. Supervision in Class B format with end-of-line resistor.
 - .3 Complete with lamicaid identification on cover identifying address and device monitored.

2.9 Addressable Control Modules

- .1 Addressable control elements to meet or exceed the following technical requirements:
 - .1 Compatible with main fire alarm system.
 - .2 Complete with lamicaid identification on cover identifying address and device controlled.

2.10 Mechanical System Control

- .1 Provide control of mechanical system air handling equipment during an alarm condition, as indicated on the drawings and specified under the Mechanical Division.
- .2 Provide the following:
 - .1 BMS interface to send the Fire Alarm status and commands as indicated.
 - .2 All wiring, connections, relay modules, etc. as required.
 - .3 Dual voltage relays as required.
 - .4 Separate relay for each system as indicated in motor schedule.

- .5 Minimum one set of Form "C" contacts for each system accessed via clearly labeled terminal strip located adjacent to MCC or starter. Provide general purpose enclosure or use spare (barriered) section of MCC.
- .6 Fan shutdown shall be achieved by wiring fan starter control circuit through appropriate alarm operated contacts located in the fire alarm panel. Use interposing relays and do not run 120V or higher motor feeder voltages through fire alarm system cabinets.

2.11 Sprinkler System Connections

- .1 Connect all sprinkler (fire protection) system pressure, flow, and tamper switches. Coordinate with the Fire Protection Division for exact device locations, grouping and zoning.
- .2 Supply and install wiring to sprinkler alarm and supervisory devices to provide alarm and trouble indications for the sprinkler system at the Fire Alarm annunciator and remotely to the fire alarm panel.
- .3 Coordinate with division 21, 22, fire protection drawings, and confirm location of all alarm and supervisory devices.
- .4 The automatic sprinkler system shall be fully supervised and hydraulically designed in accordance with NFPA 13 "Standard for the Installation of Sprinkler Systems".
 - .1 Sprinkler flow switches, and pressure switches shall be provided by mechanical division. Extend wiring from the fire alarm addressable loop to each sprinkler flow switch/pressure switch so that when the switch operates, a fire alarm signal is initiated. Sprinkler flow zoning shall be as shown on the drawings and shall be separate zones from the manual breakglass and automatic device (thermal detection, smoke detection) circuits.
- .5 Electrical Supervision:
 - .1 Sprinkler control valves including backflow prevention devices
 - .2 Flow alarm switches
 - .3 Low air pressure switches
 - .4 A temperature
 - .5 Approaching the freezing point in a heat tracing system if a heat tracing system is required.
- .6 Fire alarm monitoring shall be provided for:
 - .1 Wet alarm check valve
 - .2 Dry alarm check valve
 - .3 Pre-action valve
 - .4 Heat trace
 - .5 Generators running and trouble
 - .6 Fire pump running and trouble

2.12 Programming

- .1 Provide a list of all devices and the related LCD messaging and Audio readouts for review by Consultant and Owner: Submit as part of shop drawings.

- .2 This contract to include software re-program for all the equipment installed under this Contract. These software generations to include all memory storage devices and burn-in based on devices, control points and monitor points installed under this Contract.

2.13 **MANUAL ALARM STATIONS**

- .1 Provide non-coded single action type with mechanical reset features.
 - .1 Non-coded single pole normally open contact for single stage.
 - .2 General alarm key switch for two stage system.
- .2 Stations: surface mounted and interior type as indicated.
 - .1 For surface mounting provide station manufacturer's approved back box.
 - .2 Back box finish to match station finish.
- .3 Equip each station with terminal strip with contacts of proper number and type to perform functions required.
- .4 Stations: type not subject to operation by jarring or vibration.
 - .1 Break-glass-front stations are not permitted; [pull-lever break-rod type is acceptable provided presence of rod is not required to reset station].
- .5 Station colour: red.
- .6 Provide station with visible indication of operation.
- .7 Restoration to require use of key.
 - .1 Keys: identical throughout system for stations and control panel(s).
- .8 Mount stations with operating lever not more than [1.2] m above finished floor.
- .9 Where weatherproof stations are required, provide stations with cast metal, weatherproof housings with hinged access doors.
 - .1 Finish housings with red enamel paint and provide permanently affixed signage indicating "FIRE ALARM" with white letters of [19] mm high.

2.14 **AUTOMATIC ALARM INITIATING DEVICES**

- .1 Heat detectors: provide heat detectors designed for detection of fire by [combination fixed temperature rate-of-rise] [rate compensating] [line-type fixed temperature] principle.
- .2 Combination Fixed Temperature Rate-Of-Rise Detectors (Spot Type): designed for surface, semi-flush outlet box mounting and supported independently of conduit, tubing or wiring connections.
 - .1 Contacts: self-resetting after response to rate-of-rise actuation
 - .2 Operation under fixed temperature actuation to result in external indication.
 - .3 Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes to operate on fixed temperature principle only.
- .3 Rate Compensating Detector (Spot Type): designed for [surface] [flush] [vertical unit] outlet box mounting and supported independently of conduit, tubing or wiring connections.
 - .1 Detectors: hermetically sealed and automatically resetting type which will operate when ambient air temperature reaches detector setting regardless of rate of temperature rise.
 - .2 Detector operation: not be subject to thermal time lag.

- .4 Line-Type Fixed Temperature Detectors: provide [thermostatic] [thermistor] line-type heat detection cable [with weather-resistant outer covering] where indicated.
 - .1 Cable: nominally rated for temperature of [68] [88] [138] degrees C and operate on fixed temperature principle.
- .5 Open-Area Smoke Detectors: provide detectors designed for detection of abnormal smoke densities by ionization principle.
 - .1 Provide necessary control and power modules required for operation integral with control panel.
 - .2 Detectors and associated modules: compatible with control panel and suitable for use in supervised circuit.
 - .3 Malfunction of electrical circuits to detector or its control or power units to result in operation of system trouble signals.
 - .4 Equip each detector with visible indicator lamp that will flash when detector is in normal standby mode and glow continuously when detector is activated.
 - .5 Provide remote indicator lamps for each detector that is located [above suspended ceilings], [beneath raised floors], [concealed from view].
 - .6 Each detector: plug-in type with tab-lock or twist-lock, quick disconnect head and separate base in which detector base contains screw terminals for making wiring connections.
 - .7 Detector head: removable from its base without disconnecting wires. Removal of detector head from its base to cause activation of system trouble signals.
 - .8 Screen each detector to prevent entrance of insects into detection chamber(s).
- .6 4-Wire Smoke Detectors: detector circuits 4-wire type capable of transmitting detector operating power over conductors separate from initiating circuit.
 - .1 Provide separate, power circuit for each smoke detection initiating circuit (zone).
 - .2 Failure of power circuit to be indicated as trouble condition on corresponding initiating circuit.
- .7 2-Wire Smoke Detectors: detector circuits of 2-wire type capable of transmitting detector operating power over initiating circuit are permitted, provided detectors used are approved by control panel manufacturer for use with control panel provided and are ULC listed as being compatible with control panel.
 - .1 Total number of detectors on any detection circuit: not exceed 80% of maximum number of detectors allowed by control panel manufacturer for that circuit. Provide additional zones if required to meet this requirement.
- .8 Ionization Detectors: multiple chamber type responsive to both invisible and visible particles of combustion.
 - .1 Detectors: not susceptible to operation by changes in relative humidity.
- .9 Photoelectric Detectors: operate on light scattering principle using LED light source.
 - .1 Detector: respond to both flaming and smoldering fires.
- .10 Locate detectors in accordance with their listing by ULC and the requirements of NFPA 72, except provide at least [2] detectors in rooms of [54] square meters or larger in area.
- .11 Mount detectors at underside of ceiling or deck above unless otherwise indicated.
 - .1 For mounting heights greater than [3] m above floor level, reduce actual detector linear spacing from listed spacing as required by NFPA 72.

- .2 For heights greater than [9] m space detectors no farther apart than [34]% of their listed spacing.
 - .12 Temperature rating of detectors: in accordance with NFPA 72.
 - .13 Locate detectors minimum [300] mm to lighting fixtures and not closer than [600] mm to air supply or return diffuser.
 - .14 Ensure detectors, located in areas subject to moisture or exterior atmospheric conditions or hazardous locations as defined by NFPA 70, are approved for such locations.
 - .15 Provide detectors with terminal screw type connections.
 - .16 Removal of detector head from its base to cause activation of system trouble signals if detectors are provided with separable heads and bases.
- 2.15 ALARM INITIATING DEVICE SPACING AND LOCATION**
- .1 Detector spacing and location: in accordance with manufacturer's recommendations and requirements of NFPA 72.
 - .2 Provide at least [2] detectors in rooms of [54] square meters or larger.
 - .3 Spacing: not to exceed [9] m by [9] m per detector, and [9] linear m per detector along corridors.
 - .4 Locate detectors minimum [0.9] [1.5] m from air discharge or return grille, and not closer than [300] mm to lighting fixtures.
 - .5 In areas without finished ceilings, mount detectors at underside of deck above unless otherwise indicated.
- 2.16 DUCT SMOKE DETECTORS**
- .1 Provide detectors installed in air handling system which serves more than one storey and circulates between those storeys.
 - .2 Provide integral control and power modules required for operation with main control panel.
 - .3 Ensure detectors and associated modules are compatible with main control panel and suitable for use in supervised circuit.
 - .4 Detector circuits: 4-wire type where detector operating power is transmitted over conductors separate from initiating circuit. Malfunction of electrical circuits to detector or its control or power modules to cause operation of system trouble signals.
 - .5 Provide a separate, fused power circuit for each smoke detection initiating circuit.
 - .6 Failure of power circuit: indicated as a trouble condition on corresponding initiating circuit.
 - .7 Provide duct detectors in accordance with NFPA 90A.
 - .8 Provide duct detectors with approved duct housing, mounted exterior to duct, with perforated sampling tubes extending across width of duct.
 - .9 Activation of duct detectors to cause [shutdown of associated air handling unit] annunciation at control panel and tripping of [master box] [transmitter] and sounding of building evacuation alarms.
 - .10 Provide detectors with visible indicator lamp that flashes when detector is in normal standby mode and glows continuously when detector is activated.
 - .11 Provide remote indicator lamp for each detector.
 - .12 Permanently label remote indicator with [description] [number] of associated air handling unit(s).

- .13 Provide each detector with remote test switch. Mount switch not more than[1.8] m above finished floor.
- .14 Permanently label test switch with [description] [number] of associated air handling unit(s).
- .15 Do not use mirrors to alter direction of projected beam.

2.17 SMOKE DETECTORS

- .1 Shall be provided in the following locations:
 - .1 At the top of stair shafts
 - .2 At every third level of exit stair shaft
 - .3 In the vicinity of draft stops
 - .4 In the elevator machine room
 - .5 In the elevator lobbies on every level to provide the automatic recall and alternative floor recall functions.

2.18 AUDIBLE SIGNAL DEVICES

- .1 Audible signals will provide sound pressure levels at least 10dB above ambient noise (minimum 65dB) In all areas of the building, but shall not exceed 110dB
- .2 Provide appliances specifically listed for outdoor use in locations exposed to weather.
- .3 Finish appliances in red enamel.
- .4 For surface mounting provide appliance manufacturer's approved back box. Back box finish to match appliance finish.

2.19 END-OF-LINE DEVICES

- .1 End-of-line devices to control supervisory current in [alarm circuits] [signalling circuits], sized to ensure correct supervisory current for each circuit. Open [, short] or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel [and remotely as indicated].

2.20 VISUAL ALARM SIGNAL DEVICES

- .1 Surface mounted assembly of stroboscopic type suitable for use in electrically supervised circuit and powered from notification appliance circuit[s]. provide strobes throughout the building.
- .2 Appliances: minimum of 110 candela measured as approved by ULC, but not less than effective intensity required by the National Building Code of Canada for appliance spacing and location.
- .3 Protect lamps with thermoplastic lens and labelled "FIRE" .
- .4 Provide visible appliances as indicated.

2.21 ELECTRO-MAGNETIC DOOR HOLDER-RELEASES

- .1 Provide as indicated on the drawings.
- .2 Mount armature portion on door. Armature complete with adjusting screw for setting angle of contact plate.
- .3 Mount electro-magnetic release on wall or in wall recess behind door.
- .4 Activation of [fire alarm system] [smoke detector] [smoke detector designated for door release service] to release doors on circuit to close.

- .5 Total projection of door holder-release not to exceed [100] mm.
- .6 Door holders: not require battery backup power.

2.22 VALVE TAMPER SWITCHES

- .1 Provide switches to monitor open position of valves controlling water supply to sprinkler systems.
- .2 Switch contacts to transfer from normal position to off-normal position during first two revolutions of hand wheel or when stem of valve has moved not more than one-fifth of distance from its normal position.
- .3 Provide switch with tamper resistant cover.
- .4 Removal of the cover to cause switch to operate into off-normal position.

2.23 WIRING

- .1 Wire for 120 V circuits: No. 12 AWG minimum solid copper conductor.
- .2 Wire for low voltage DC circuits: No. 14 AWG minimum solid copper conductor
- .3 Wire to remote annunciators: No. 18 AWG minimum solid copper conductor.
- .4 Wire for connection to base telegraphic alarm loop: No. [10] [12] AWG minimum solid copper conductor.
- .5 Insulation [75] degrees C minimum with nylon jacket.
- .6 For underground or wet allocations cable from control panel to [master box] [auxiliary transmitter] and to telegraphic loop: type UF.
- .7 Colour code wiring.

2.24 AS-BUILT RISER DIAGRAM

- .1 Provide as-built riser diagram on record drawings and O+M manual.

2.25 ANCILLARY DEVICES

- .1 Remote relay unit to initiate fan shutdown.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

- .1 Install systems in accordance with CAN/ULC-S524 and at locations in accordance with the manufacturer's layout drawings.
- .2 Each device shall be clearly identified with its zone and address number, using machine-printed clear adhesive tape with black lettering.
- .3 Mounting heights for devices:
 - .1 Manual stations between +1200AFF to +1400AFF. Recommended:1370mm
 - .2 Audible signal devices at 2300mm above floor
 - .3 Visual signal devices at 2300mm above floor
 - .4 End-of-line devices at 1800mm above floor.

- .4 All fire alarm system junction boxes, conduits, and wiring shall be painted and identified.
- .5 Sprinkler devices shall be wired for wet areas using liquid-tight flexible conduit. Junction boxes less than 1800mm away from the sprinkler device shall also be suitable for wet area installation.
- .6 Door mags and door hold-open devices shall have their respective power circuit numbers identified on them in conspicuous location. Labels shall be black text on clear adhesive tape.
- .7 Integrate the fire alarm system with the following systems as indicated and/or as required by code or standard.
 - .1 HVAC system
 - .2 Sprinkler system
 - .3 Door security system.
- .8 Wiring shall be installed in conduit and shall be as recommended by the system manufacturer and as required by the CEC.
- .9 Install main control panel and connect to ac power supply, ac standby power.
- .10 Locate and install manual alarm stations and connect to alarm circuit wiring.
- .11 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.
- .12 Connect alarm circuits to main control panel.
- .13 Locate and install signal, chimes, horns, and visual signal devices] and connect to signalling circuits.
- .14 Connect signalling circuits to main control panel.
- .15 Install end-of-line devices [at end of alarm and signalling circuits].
- .16 Locate and install door releasing devices.
- .17 Locate and install remote relay units to control fan shut down.
- .18 Sprinkler system: wire alarm and supervisory switches and connect to control panel.

3.3 FIELD QUALITY CONTROL

- .1 Site Tests:
 - .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical, and CAN/ULC-S537.
 - .2 Fire alarm system:
 - .1 Test such device and alarm circuit to ensure manual stations, thermal and smoke detectors sprinkler system transmit alarm to control panel and actuate general alarm ancillary devices.
 - .2 Check annunciator panels to ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.
 - .4 Simulate and test all sprinkler valve operations, including tamper and flow switches to ensure proper annunciation on supervisory zones.
 - .5 Simulate and test all auxiliary functions.

- .6 Simulate and test alarm and monitoring indication functions at building's control & automation panel.
- .7 Class A circuits.
 - .1 Test each conductor on circuits for capability of providing alarm signal on each side of single open-circuit fault condition imposed near midmost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
 - .2 Test each conductor on circuits for capability of providing alarm signal during ground-fault condition imposed near midmost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
- .8 Class B circuits.
 - .1 Test each conductor on circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
 - .2 Test each conductor on circuits for capability of providing alarm signal during ground-fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .3 Verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Low-emitting materials.

3.4 Magnetic Locks, Security Systems and Doorholders

- .1 Interface Magnetic Locks and Security release systems to the Fire Alarm System.
- .2 Interface Smoke Control Doorholders to the Fire Alarm System.
- .3 Coordinate with door hardware.

3.5 Mechanical System Control

- .1 Provide control of mechanical system air handling equipment during an alarm condition, as indicated on the drawings and specified under the Mechanical Division.
- .2 Provide the following:
 - .1 BMS interface to send the Fire Alarm status and commands as indicated.
 - .2 All wiring, connections, relay modules, etc. as required.
 - .3 Dual voltage relays as required.
 - .4 Separate relay for each system as indicated in motor schedule.
 - .5 Minimum one set of Form "C" contacts for each system accessed via clearly labeled terminal strip located adjacent to MCC or starter. Provide general purpose enclosure or use spare (barriered) section of MCC.
 - .6 Fan shutdown shall be achieved by wiring fan starter control circuit through appropriate alarm operated contacts located in the fire alarm panel. Use interposing relays and do not run 120V or higher motor feeder voltages through fire alarm system cabinets.

3.6 Sprinkler System Connections

- .1 Connect all sprinkler (fire protection) system pressure, flow, and tamper switches. Coordinate with the Fire Protection Division for exact device locations, grouping and zoning.
- .2 Supply and install wiring to sprinkler alarm and supervisory devices to provide alarm and trouble indications for the sprinkler system at the Fire Alarm annunciator and remotely to the fire alarm panel.
- .3 Coordinate with division 21, 22, fire protection drawings, and confirm location of all alarm and supervisory devices.
- .4 The automatic sprinkler system shall be fully supervised and hydraulically designed in accordance with NFPA 13 "Standard for the Installation of Sprinkler Systems".
 - .1 Sprinkler flow switches, and pressure switches shall be provided by mechanical division. Extend wiring from the fire alarm addressable loop to each sprinkler flow switch/pressure switch so that when the switch operates, a fire alarm signal is initiated. Sprinkler flow zoning shall be as shown on the drawings and shall be separate zones from the manual breakglass and automatic device (thermal detection, smoke detection) circuits.
- .5 Provide the following zoning to monitor the sprinkler (fire protection) system:
 - .1 Separate alarm zone for each wet sprinkler zone, one per floor in stairwell #3.
 - .2 Separate fire alarm zone for the dry sprinkler zone
 - .3 New wet alarm check valve monitoring
 - .4 New dry zone valve monitoring
 - .5 New pre-action system.
 - .6 Separate trouble indication for each tamper protected gate valve. Provide separate address for each device even though they may be grouped or loop fed.
- .6 Fire alarm monitoring shall be provided for:
 - .1 New wet alarm check valve

- .2 New dry alarm check valve
- .3 New pre-action valve
- .4 New heat trace
- .5 Generators running and trouble

3.7 Programming

- .1 Provide a list of all devices and the related LCD messaging and Audio readouts for review by Consultant and Owner: Submit as part of shop drawings.
- .2 This contract to include software re-program for all the equipment installed under this Contract. These software generations to include all memory storage devices and burn-in based on devices, control points and monitor points installed under this Contract.

3.8 Training

- .1 Arrange and pay for on-site lectures and demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

3.9 Protection of Completed Work

- .1 Protect equipment in areas of construction to prevent the entry of dust, paint and any other foreign matter into the devices or panels.

3.10 System Inspection

- .1 Carry out a complete inspection and test of system on completion of the installation to ensure the following:
 - .1 System is complete and functional in accordance with the contract documents and regulatory requirements.
 - .2 System in installed in accordance with the manufacturer's recommendations.
 - .3 Fire suppression detection devices are connected into the system and are functioning.
 - .4 Smoke control equipment has been installed, connected and functioning.
 - .5 All auxiliary equipment has been connected and functioning.
 - .6 On completion of inspection deliver three (3) final sets of maintenance and operating instructions manuals to the Consultant.

3.11 Performance Verification

- .1 The Electrical Division Contractor shall be responsible for directing performance verification of the fire alarm system in accordance with the latest CAN-S537, Standard for Verification of Fire Alarm System Installations.
- .2 Provide interim partial verifications to suit the progress of the work and any staged occupancy. All new work to be tested and verified directly following the installation.
- .3 Submit all verification reports to the Consultant. Provide an unconditional Appendix C and written test reports from the equipment manufacturer showing that the ENTIRE system has been tested, verified and commissioned by him in accordance with the latest edition of ULC S-537 "Standard for Verification of Fire Alarm System Installations" and that the Fire Alarm system complies with all points of the specifications. Include the verification worksheets identifying every device and its status (i.e. smoke detector - room xx, verified for operation and supervision).
- .4 The qualified Fire Alarm verification agency shall be independent of the installing company.

- .5 Prior to requesting the final performance verification ensure that fire alarm system is fully operable and that subsequent work to be performed on system will not invalidate examinations and tests performed during verification procedure.
- .6 The Electrical Division Contractor and fire alarm system manufacturer's representative shall be present at all times during the verification procedure and shall undertake the following:
 - .1 Provide all required testing equipment and tools.
 - .2 Disassemble and reassemble system components.
 - .3 Disconnect and reconnect wiring.
 - .4 Perform required field adjustments.
 - .5 Repair defective work and replace defective components.
 - .6 Perform all other work on the system required by verification procedure.
 - .7 Provide four portable communication devices during entire verification.
- .7 Include all costs for fire alarm system verifications, including the Fire Alarm System Manufacturer's representative's costs. Take into account that the system may have to be commissioned and verified after normal working hours.
- .8 Provide a minimum of ten working days written notice ahead of the verification process to the Owners Representatives and the Consultant.
- .9 Provide to Camosun a schedule of elevator operation and security doors on maglock function during an alarm.
- .10 Coordinate verification of the fire alarm system with Camosun. Contact Camosun Building Operations in advance of verification to provide opportunity for work crews to be present during verification.

3.12 Fire Department Demonstration

- .1 Arrange, attend, and carry out a Fire Department demonstration of the completed system after the final unconditional verification.
- .2 Activate alarms and demonstrate all controls as requested.

3.13 LABELING

- .1 The company name and phone number of the fire alarm monitoring company and a clear statement that the equipment is being monitored and that notification must be given prior to working on or testing of the fire alarm system shall be prominently displayed on the DACT as well as the fire alarm panel, as required by CAN/ULC-S561 article 9.2.2.
- .2 When DACT transmit signals for other systems such as intrusion alarm system to the monitoring company, include all systems monitored on the same label and display the label on the control panels of other monitored systems as well.

3.14 CLEANING

- .1 Proceed in accordance with Section 01 00 10 – General Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International (ASTM)
 - .1 [ASTM D4791-10](#), Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
- .2 United States Environmental Protection Agency (EPA)/Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for aggregate materials and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Provide Consultant with access to source and processed material for sampling.
 - .2 Pay cost of sampling and testing of aggregates which fail to meet specified requirements.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Transportation and Handling: handle and transport aggregates to avoid segregation, contamination and degradation.
- .2 Storage: store washed materials or materials excavated from underwater 24 hours minimum to allow free water to drain and for materials to attain uniform water content.

Part 2 Products

2.1 MATERIALS

- .1 Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, free from adherent coatings and injurious amounts of disintegrated pieces or other deleterious substances.
- .2 Flat and elongated particles of coarse aggregate: to [ASTM D4791](#)
 - .1 Greatest dimension to exceed 5 times least dimension.
- .3 Fine aggregates satisfying requirements of applicable section to be one, or blend of following:
 - .1 Screenings produced in crushing of quarried rock, boulders, gravel or slag.
- .4 Coarse aggregates satisfying requirements of applicable section to be one of or blend of following:
 - .1 Crushed rock.
 - .2 Gravel and crushed gravel composed of naturally formed particles of stone.
 - .3 Light weight aggregate, including slag and expanded shale.

2.2 SOURCE QUALITY CONTROL

- .1 Inform Consultant of proposed source of aggregates and provide access for sampling 4 weeks minimum before starting production.
- .2 If materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate alternative source.
- .3 Advise Consultant 4 weeks minimum in advance of proposed change of material source.
- .4 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions are acceptable for topsoil stripping.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with topsoil stripping, only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 PREPARATION

- .1 Topsoil stripping:
 - .1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected.
 - .2 Begin topsoil stripping of areas as indicated after area has been cleared of brush, weeds and grasses and removed from site.
 - .3 Strip topsoil to depths as indicated. Avoid mixing topsoil with subsoil.
 - .4 Stockpile in locations as indicated. Stockpile height not to exceed 2 m.
 - .5 Dispose of topsoil off site.
- .2 Aggregate source preparation:
 - .1 Prior to excavating materials for aggregate production, clear and grub area to be worked, and strip unsuitable surface materials. Dispose of cleared, grubbed and unsuitable materials as approved by authority having jurisdiction.
 - .2 Where clearing is required, leave screen of trees between cleared area and roadways as directed.
 - .3 Clear, grub and strip area ahead of quarrying or excavating operation sufficient to prevent contamination of aggregate by deleterious materials.
 - .4 When excavation is completed dress sides of excavation to nominal 1.5:1 slope, and provide drains or ditches as required to prevent surface standing water.
 - .5 Trim off and dress slopes of waste material piles and leave site in neat condition.
 - .6 Provide silt fence or other means to prevent contamination of existing watercourse or natural wetland features.
- .3 Processing:

- .1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.
- .2 Blend aggregates, as required, including reclaimed materials that meet physical requirements of specification is permitted in order to satisfy gradation requirements for material and, percentage of crushed particles, or particle shapes specified.
 - .1 Use methods and equipment approved in writing by Consultant.
- .4 When operating in stratified deposits use excavation equipment and methods that produce uniform, homogeneous aggregate gradation.
- .5 Where necessary, screen, crush, wash, classify and process aggregates with suitable equipment to meet requirements.
 - .1 Use only equipment approved in writing by Consultant.
- .6 Stockpiling:
 - .1 Stockpile aggregates on site in locations as indicated unless directed otherwise by Consultant. Do not stockpile on completed pavement surfaces.
 - .2 Stockpile aggregates in sufficient quantities to meet project schedules.
 - .3 Stockpiling sites to be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.
 - .4 Except where stockpiled on acceptably stabilized areas, provide compacted sand base not less than 300 mm in depth to prevent contamination of aggregate. Stockpile aggregates on ground but do not incorporate bottom 300 mm of pile into Work.
 - .5 Separate different aggregates by strong, full depth bulkheads, or stockpile far enough apart to prevent intermixing.
 - .6 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Consultant within 48 hours of rejection.
 - .7 Stockpile materials in uniform layers of thickness as follows:
 - .1 Maximum 1.5 m for coarse aggregate and base course materials.
 - .2 Maximum 1.5 m for fine aggregate and sub-base materials.
 - .3 Maximum 1.5 m for other materials.
 - .8 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
 - .9 Do not cone piles or spill material over edges of piles.
 - .10 Do not use conveying stackers.
 - .11 During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.

3.3 CLEANING

- .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .2 Leave aggregate stockpile site in tidy, well drained condition, free of standing surface water.
- .3 Leave any unused aggregates in neat compact stockpiles as directed by Consultant.

- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
- .5 For temporary or permanent abandonment of aggregate source, restore source to condition meeting requirements of authority having jurisdiction.
- .6 Restrict public access to temporary or permanently abandoned stockpiles by means acceptable to Consultant.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

- .1 Clearing: Consists of cutting off trees and brush vegetative growth to not more than specified height above ground and disposing of felled trees, previously uprooted trees and stumps, and surface debris.
 - .1 Close-cut clearing: Consists of cutting off standing trees, brush, scrub, roots, stumps and embedded logs, removing at, or close to, existing grade and disposing of fallen timber and surface debris.
 - .2 Clearing isolated trees: Consists of cutting off to not more than specified height above ground of designated trees, and disposing of felled trees and debris.
 - .3 Underbrush clearing: Consists of removal from treed areas of undergrowth, deadwood, and trees smaller than 50 mm trunk diameter and disposing of fallen timber and surface debris.
- .2 Grubbing: Consists of excavation and disposal of stumps and roots , boulders and rock fragments of specified size to not less than specified depth below existing ground surface.

1.2 REFERENCE STANDARDS

- .1 Canada Labour Code, Part 2, Canada Occupational Health and Safety Regulations.
- .2 Canadian Environmental Protection Act, 1999 (CEPA 1999).
- .3 Yukon Government. Workers' Compensation Act (2021) and the Occupational Health and Safety Act (2022).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Arrange for a site meeting, before Work starts, with Consultant in accordance with project meeting protocols to:
 - .1 Verify project requirements.
 - .2 Examine existing site conditions and adjacent areas to construction's work, before Work starts.
 - .3 Identify potential environmental impact on existing site conditions.
- .2 Contractor is responsible for obtaining or coordinating any permits required for clearing and grubbing works.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit list of equipment that are going to be on-site.

1.5 HEALTH AND SAFETY

- .1 Perform clearing and grubbing work in accordance with the site-specific HSP recommendations.
- .2 Safety Requirements: Worker protection.
 - .1 Ensure workers are wearing long sleeved clothing, dust masks, protective clothing, safety boots, eye protection, safety vests while performing clearing and grubbing activities.

- .2 Ensure that workers are not allowed to eat, drink or smoke while applying herbicide.

1.6 QUALITY CONTROL

- .1 Regulatory Requirements:
 - .1 Ensure Work is performed in compliance with CEPA and applicable Territorial and municipal regulations.
 - .2 Comply with hauling and disposal regulations of authority having jurisdiction.
- .2 Qualifications:
 - .1 Submit proof of qualifications when requested by Consultant.
 - .2 Qualification Statement: Contractor have documented proof that they have completed work of similar scope.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Prevent damage to trees, shrubs, landscaping, existing buildings, existing pavement, utility lines, root systems of trees, existing pavement, water courses which are to remain.
 - .1 Repair damaged items to approval of Consultant.
 - .2 Replace any damaged trees designated to remain, as directed by Consultant.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Perform clearing and grubbing work in accordance with the site-specific EPP recommendations as directed by Consultant.
- .2 Ensure safe disposal of wood preservatives complies with all Federal, Territorial and municipal regulations, particularly the Canadian Environmental Assessment Act (CEAA), the Canadian Environmental Protection Act, and the Pest Control Products Act.
 - .1 For information and procedures on pest control products, call the Pest Management Information Service at 1-800-267-6315.
- .3 Waste Management and Disposal:
 - .1 Separate waste materials in accordance with Section 01 00 10 - General Requirements.
 - .2 Consider felled timber from which saw logs, pulpwood, posts, poles, ties, or fuel wood can be produced as saleable timber.
 - .3 Stockpile saleable timber at location adjacent to site as directed by Consultant.
 - .4 Remove soil and stockpile soil material free of debris for reuse as backfill materials.

Part 2 Products

2.1 MATERIALS

- .1 Ensure that pesticides delivered to the site are registered by Health Canada as part of the Pest Control Products Act.
- .2 Soil Material for Fill:
 - .1 Excavated soil material: Free of debris, roots, wood, scrap material, vegetable matter, refuse, soft unsound particles, deleterious, or objectionable materials.

Part 3 Execution

3.1 PREPARATION

- .1 Inspect site and verify with Consultant, any items designated to remain.
- .2 Locate and protect utility lines: Preserve in operating condition active utilities traversing site.
 - .1 Notify Consultant immediately of damage to or when unknown existing utility line(s) are encountered.
 - .2 When utility lines which are to be removed are encountered within area of operations, notify Consultant in ample time to minimize interruption of service.
- .3 Notify utility authorities before starting clearing and grubbing.
- .4 Keep roads and walks free of dirt and debris.

3.2 CLEARING

- .1 Clearing includes felling, trimming, and cutting of trees into sections and satisfactory disposal of trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within cleared areas.
- .2 Clear as directed by Consultant, by cutting at height of not more than 300mm above ground. In areas to be subsequently grubbed, height of stumps left from clearing operations to be not more than 1000mm above ground surface.
- .3 Cut off branches overhanging area cleared as directed by Consultant.
- .4 Cut off unsound branches on trees designated to remain as directed by Consultant.

3.3 CLOSE CUT CLEARING

- .1 Close cut clearing to ground level.
- .2 Cut off branches overhanging area cleared as directed by Consultant.
- .3 Cut off unsound branches on trees designated to remain as directed by Consultant.

3.4 ISOLATED TREES

- .1 Cut off isolated trees as directed by Consultant at height of not more than 300mm above ground surface.
- .2 Grub out isolated tree stumps.
- .3 Prune individual trees as indicated.
- .4 Trim trees designated to be left standing within cleared areas of dead branches 4cm or more in diameter; and trim branches to heights as indicated.
- .5 Cut limbs and branches to be trimmed close to bole of tree or main branches.

3.5 UNDERBRUSH CLEARING

- .1 Clear underbrush from areas as indicated at ground level.

3.6 GRUBBING

- .1 Remove and dispose of roots larger than 7.5cm in diameter, matted roots, and designated stumps from indicated grubbing areas.

- .2 Grub out stumps and roots to not less than 200mm below ground surface.
- .3 Grub out visible rock fragments and boulders, greater than 300mm in greatest dimension, but less than 0.25m³.
- .4 Fill depressions made by grubbing with suitable material and to make new surface conform with existing adjacent surface of ground.

3.7 REMOVAL AND DISPOSAL

- .1 Remove cleared and grubbed materials off site to disposal area designated by Consultant.
- .2 Cut timber greater than 125mm diameter to 2400 mm lengths and stockpile as indicated. Stockpiled timber becomes property of Owner.
- .3 Chip and spread cleared and grubbed vegetative material on site as directed by Consultant.

3.8 FINISHED SURFACE

- .1 Leave ground surface in condition suitable for immediate grading operations to approval of Consultant.

3.9 CLEANING

- .1 Clean and remove debris and sediment from work area drainage devices and dispose of to an approved landfill site.
- .2 Do not clean equipment in the waterbody or where the wash-water can enter the waterbody.
- .3 Maintain tidy Work area, free from accumulation of waste products and debris.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 11 00 - Clearing and grubbing.

1.2 REFERENCE STANDARDS

- .1 United States Environmental Protection Agency (EPA)/Office of Water
 - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 STRIPPING OF TOPSOIL

- .1 Ensure that procedures are conducted in accordance with applicable Territorial and Municipal requirements.
- .2 Remove topsoil before construction procedures commence to avoid compaction of topsoil.
- .3 Handle topsoil only when it is dry and warm.
- .4 Remove vegetation from targeted areas by non-chemical means and dispose of stripped vegetation by composting.
- .5 Remove brush from targeted area by non-chemical means and dispose of through alternative disposal.
- .6 Strip topsoil to depths as directed by Consultant.
 - .1 Avoid mixing topsoil with subsoil.
- .7 Pile topsoil by mechanical hoe in berms in locations as directed by Consultant.
 - .1 Stockpile height not to exceed 2.5 - 3 m.
- .8 Dispose of unused topsoil off-site.
- .9 Protect stockpiles from contamination and compaction.
- .10 Cover topsoil that has been piled for long term storage, with trefoil or grass to maintain agricultural potential of soil.

3.3 PREPARATION OF GRADE

- .1 Verify that grades are correct and notify Consultant if discrepancies occur do not begin work until instructed by Consultant.
 - .1 Grade area only when soil is dry to lessen soil compaction.
 - .2 Grade soil establishing natural contours and eliminating uneven areas and low spots, ensuring positive drainage.

3.4 PLACING OF TOPSOIL

- .1 Place topsoil only after Consultant has accepted subgrade.
- .2 Spread topsoil during dry conditions by mechanical hoe in uniform layers not exceeding 200 mm, over unfrozen subgrade free of standing water.
- .3 Establish traffic patterns for equipment to prevent driving on topsoil after it has been spread to avoid compaction.
- .4 Cultivate soil following spreading procedures.

3.5 CLEANING

- .1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 Intent

- .1 This section describes the minimum requirements for the supply and installation of a radon mitigation rough-in system.

1.2 References

- .1 American Concrete Institute (ACI):

.1 ACI 302.1R, Guide for Concrete Floor and Slab Construction

- .2 ASTM International (ASTM):

- .1 ASTM C33/C33M, Standard Specification for Concrete Aggregates
.2 ASTM D3786/D3786M, Standard Test Method for Bursting Strength of Textile Fabrics—
Diaphragm Bursting Strength Tester Method
.3 ASTM D4533/D4533M, Standard Test Method for Trapezoid Tearing Strength of
Geotextiles
.4 ASTM D4632/D4632M, Standard Test Method for Grab Breaking Load and Elongation of
Geotextiles
.5 ASTM D4833/D4833M, Standard Test Method for Index Puncture Resistance of
Geomembranes and Related Products
.6 ASTM D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles
.7 ASTM E154/E154M, Standard Test Methods for Water Vapor Retarders Used in Contact
with Earth Under Concrete Slabs, on Walls, or as Ground Cover
.8 ASTM E1745, Standard Specification for Plastic Water Vapor Retarders Used in Contact
with Soil or Granular Fill under Concrete Slabs

- .3 Environmental Protection Agency (EPA):

.1 EPA 625 - Radon Prevention in the Design and Construction of Schools and Other Large
Buildings.

- .4 Health Canada – Guide for Radon Measurements in Public Buildings.

1.3 Administrative Requirements

- .1 Pre-Installation Meeting:

.1 Contractor to arrange for a site meeting to review existing conditions and all requirements
related to materials, material handling and storage, installation, scheduling, testing, and
quality assurance and control, to confirm compliance with manufacturer and installation
requirements.

- .2 Submittals:

- .1 Submit component product information. This includes the geotextile fabric, gas permeable
venting layer, membrane barrier system, suction pit and cage, collection/extension/riser
piping, and sealing methods for the slab perimeters and penetrations.
.2 Provide final as-building Drawings that indicate the final locations of the
collection/extension/riser pipes and the suction pits and cages.

1.4 Delivery, Handling and Storage

- .1 Ensure all products delivered to the site meet manufacturer's quality requirements. Remove and do not use any defective products. Store and handle materials as per manufacturer's requirements, recommendations and safety data sheets. Protect materials from construction and weather related damage using appropriate coverings and adequate ventilation.

1.5 Environmental / Site Conditions

- .1 All products and materials are to be stored at temperatures and environmental conditions that conform to manufacturer guidelines.
- .2 Perform installation work only when the weather conditions are within installation guidelines established by manufacturer.
- .3 Do not proceed with membrane barrier system installation until confirmation that the substrate preparation and condition is suitable.
- .4 Do not proceed with the concrete slab pour until confirmation that the membrane barrier system preparation and condition is suitable.

1.6 Performance Requirements

- .1 Installation of the geotextile fabric, gas permeable layer, suction pits and cages, collection/extension/riser pipes, membrane barrier system, and sealing methods for the slab perimeters and penetrations for the building concrete in contact with the soil, is to comply with manufacturers requirements, system design, and the requirements of this specification.
- .2 All system components are to be chemically compatible with the soil environment (ASTM E154/E154M).
- .3 The radon rock (gas permeable venting layer) is to be a minimum 100 mm layer of clean, coarse, aggregate meeting Size #5 specifications as defined in ASTM C33, and as stated in EPA 625. Other venting types may be proposed by the Certified Mitigation Professional in the system design.
- .4 The radon membrane barrier system (also is the vapour barrier) is to be a minimum, 10 mil polyolefin based resin sheet membrane, meeting the requirements of ASTM E1745.
- .5 Radon membrane barrier system is to be overlapped and sealed at all perimeters and floor slab penetrations to provide a continuous seal of the building area in contact with the soil, as per manufacturer requirements, system design, and the requirements of this specification.
- .6 Install and seal floor drains, suction pits/cages and collection/extension/riser pipes in accordance with EPA/625/R-92/016 - Radon Prevention in the Design and Construction of Schools and Other Large Buildings.

2. PRODUCTS

2.1 Geotextile Fabric

- .1 The geotextile fabric is to be installed on the subsoil below the radon rock gas permeable venting layer. The geotextile fabric protects the gas venting layer from being contaminated with fines from the subsoil.
- .2 The geotextile fabric is to have the following physical characteristics:
 - .1 Non-woven fiber construction with an apparent opening size of 0.15mm.
 - .2 Unit weight of 340g/m² (ASTM D5261)

- .3 Grab tensile strength of 1100 N (ASTM D4632).
- .4 Elongation of from 45 to 105% (ASTM D4632).
- .5 Trapezoid tear resistance of 450N (ASTM D4533).
- .6 Puncture resistance of 700N (ASTM D4833).
- .7 Mullen Burst of 3600Pa (ASTM D3786).

2.2 Gas Permeable Venting Layer

- .1 The gas permeable venting layer (radon rock) is to be a minimum 100 mm layer of clean, coarse, aggregate meeting Size #5 specifications as defined in ASTM C33/C33M, and as stated in EPA 625.

2.3 Membrane Barrier System

- .1 Sheet Vapour Retarder: sheet in accordance with ASTM E1745, including manufacturer's recommended seam tape, pipe boots and vapour proofing mastic forming a complete system, and as follows:
 - .1 Vapour Permeance: 0.01 Perm or less
 - .2 Water Vapour Transmission Rate: 0.57 ng/(s·m²·Pa)
 - .3 Tensile Strength: Class A
 - .4 Thickness: Not less than 10 mil in accordance with ACI 302.1R recommendations.
 - .5 Acceptable Materials:
 - .1 Stego Industries Stego Wrap Vapour Barrier 15 mil
 - .2 W.R. Meadows, Perminator 15 mil
- .2 All membrane seams are to be prepared, overlapped and sealed as per the manufacturer's recommendations.
- .3 Supply and install Henry Blueskin WP 200, or an approved alternative, as a transition between the radon membrane and upturn onto grade beams, foundation walls, footings or any item that penetrates the finished floor slab. Joints are to be designed to accommodate anticipated movement.
- .4 The membrane is to be terminated with an upturn at the perimeter grade beams, foundation walls, footings and strip footings, and terminate between the beam, wall or footing and finished floor slab. Membrane is to terminate midway through the floor slab and be sealed and secured using Blueskin Termination Bar, mechanically fastened to the beam or footing on 300 mm centers. Sealant to be applied to junction between membrane to footing, wall or beam, above Termination Bar.
- .5 Gas tight seals are to be provided around the surfaces of all vertical penetrations. Such surfaces are to be prepared as per manufacturer's requirements to facilitate membrane adherence. Use Blueskin WP 200, sealants and construction tape as required to provide a continuous seal between radon membrane and any pipe, conduit or other item that penetrates the floor slab.
- .6 Once concrete floor slab has cured sufficiently to allow work to proceed on it, apply sealant to all penetration junctions on the top side of the finished floor slab.

2.4 Collection, Extension and Riser Pipes

- .1 The collection, extension and riser pipe locations are shown on the drawings. Place collection pipes into the clear granular material / gas permeable venting layer having a minimum, thickness of 100 mm.
- .2 The collection, extension and riser pipes are to consist of a minimum Schedule 40 non-perforated smooth walled 100 mm (inside) diameter rigid pipe of PVC, High Density PE or ABS construction.
- .3 The collection, extension and riser pipes are to be installed in accordance with the EPA/625.

- .4 A single vertical riser pipe is to be installed at each suction pit and cage location and extend from the suction pit and cage to 300 mm above the finished floor slab.

3. EXECUTION

3.1 Installation

- .1 Review footing, wall and grade beam building construction Drawings, and review radon mitigation rough to ensure proper understanding before installation.
- .2 Prepare sub-grade surface prior to installation of the geotextile fabric, suction pits and cages, and collection, extension and riser piping, as per the elevations specified in the building construction drawings and radon mitigation rough – in system design drawings and specifications.
- .3 Place geotextile fabric layer over the entire sub-grade surface, with sufficient overlaps as per the manufacturer's requirements.
- .4 Install extension/riser pipes in locations indicated.
- .5 The collection pipes are to be placed within the gas permeable venting layer.
- .6 All pipe joints are to be solvent welded and fully inserted into coupling or fitting to ensure joint integrity as per manufacturer's instructions.
- .7 If the riser pipe penetrations through the floor slab cannot be installed in the center of the sub-slab area, an extension pipe must be installed so that it extends from the center of the suction pit and cage to the preferred pipe slab penetration location.
- .8 Riser pipe installations are to ensure the same sized exhaust pipe extensions can be made to the exterior of the building through the wall or roof system, if required in the future.
- .9 The gas permeable venting layer (radon rock) is to be a minimum 100 mm layer of clean, coarse, aggregate meeting Size #5 specifications as defined in ASTM C33/C33M, and as stated in EPA 625.
- .10 The gas permeable venting layer (radon rock) is to be constructed by placing, grading and compacting (if required structurally) it over the entire sub-grade surface, geotextile layer and collection/extension/riser piping. Ensure the suction pit and cage area remains clear of the gas permeable venting layer (radon rock).
- .11 At completion of the substrate, component and gas permeable venting layer, the Contractor is to contact Consultant for review.
- .12 When acceptance of the substrate, component and gas permeable venting layer installation has been provided, the membrane barrier system construction can commence.
- .13 Membrane barrier system is to be placed over the gas permeable venting layer (radon rock). All membrane overlaps and sealing in accordance with manufacturer's requirements and Specifications.
- .14 Membrane barrier system installation is to be performed by trained qualified installers using manufacturer's recommended techniques and equipment.
- .15 Membrane barrier system is to be installed and sealed around all vertical penetrations with sufficient overlap and using Blueskin, sealant and construction tape or chemical welded seams as per manufacturer's requirements and specifications.
- .16 At completion of the membrane barrier system, contact the Consultant for review.

- .17 When acceptance of the radon mitigation rough – in system installation has been provided, the floor slab construction can commence.
- .18 Care must be taken not to puncture the membrane excessively during floor slab construction. To limit membrane puncture during floor slab construction, items such as rebar chair supports designed with a wide base (instead of legs) are to be used to better spread the rebar load.
- .19 Once concrete floor slab has cured sufficiently to allow Work to proceed on it, clean joint surfaces in accordance with manufacturer's instructions and seal all finished floor slab perimeter cold joints and any other floor slab penetration junctions between dissimilar Materials using high quality sealants suitable for use on each subject Material surface. Test sealant to confirm adhesion with all surfaces prior to use. Joints are to be pre-designed to accommodate anticipated movement.
- .20 The above slab exposed open top of the riser pipes must be capped and 100% solvent welded to provide a complete seal.
- .21 The above slab exposed riser pipe and cap are both to be labeled to identify them as part of the "Radon Mitigation Rough-in System".
- .22 At completion of the slab perimeter and penetration sealing and capping and labeling of the exposed riser pipes, contact the Consultant for review.
- .23 When acceptance of the installation of the slab perimeter and penetration sealing and capping and labeling of the exposed riser pipes has been provided, the passive radon mitigation rough-in system is considered complete.
- .24 Deficiencies in the radon mitigation rough – in system are to be corrected.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 23 33.01 - Excavating, Trenching and Backfilling

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 [ASTM D698-07e1](#), Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m³).
- .2 Underwriters' Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.4 EXISTING CONDITIONS

- .1 Examine project specific Geotechnical Reports issued by Tetra Tech, dated January 5, 2023 and April 29, 2024.
- .2 Known underground and surface utility lines and buried objects are as indicated on site plan.
- .3 Refer to dewatering in Section 31 23 33.01 - Excavating, Trenching and Backfilling.

Part 2 Products

2.1 MATERIALS

- .1 Fill material: In accordance with of Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Excavated or graded material existing on site suitable to use as fill for grading work if approved by Consultant.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for rough grading installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 STRIPPING OF TOPSOIL

- .1 Proceed in accordance with Section 31 14 13 - Soil stripping and stockpiling.

3.3 GRADING

- .1 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.

- .2 Slope rough grade away from building as directed.
- .3 Grade ditches to depth as indicated.
- .4 Prior to placing fill over existing ground, scarify surface to depth of 150 mm minimum before placing fill over existing ground. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.
- .5 Compact filled and disturbed areas to maximum dry density to [ASTM D698](#), as follows:
 - .1 95% under landscaped areas.
 - .2 98% under paved and walk areas.
 - .3 And as indicated in site specific Geotechnical Report issued by Tetra Tech on January 5, 2023 and April 29, 2024.
- .6 Do not disturb soil within branch spread of trees or shrubs to remain.

3.4 TESTING

- .1 Inspection and testing of soil compaction will be carried out by testing laboratory designated by ULC. Costs of tests will be paid by the Client.
- .2 Contractor to provide full access to the project site for the designated testing agency to complete testing required.
- .3 Contractor to be provided details of the testing procedure, frequency of tests, and testing agency and laboratory to review.

3.5 CLEANING

- .1 Progress Cleaning: Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.6 PROTECTION

- .1 Protect existing trees, landscaping, natural features, bench marks, buildings, pavement, surface or underground utility lines which are to remain as directed by Consultant. If damaged, restore to original or better condition unless directed otherwise.
- .2 Maintain access roads to prevent accumulation of construction related debris on roads.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 02 41 13 - Selective Site Demolition
- .2 Section 31 05 16 - Aggregate Materials
- .3 Section 31 14 13 - Soil Stripping and Stockpiling
- .4 Section 33 14 16 - Site Water Utility Distribution Piping
- .5 Section 33 31 11 - Public Sanitary Sewerage Gravity Piping
- .6 Section 33 41 00 - Storm Utility Drainage Piping

1.2 DEFINITIONS

- .1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
 - .1 Rock: solid material in excess of 1.00 m³ and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15 m bucket. Frozen material not classified as rock.
 - .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
- .2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .3 Topsoil:
 - .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
 - .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.
- .4 Waste material: Excavated material unsuitable for use in Work or surplus to requirements.
- .5 Borrow material: Material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.
- .6 Recycled fill material: Material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .7 Unsuitable materials:
 - .1 Weak, chemically unstable, and compressible materials.
 - .2 Frost susceptible materials:
 - .1 Fine grained soils with plasticity index less than 10 when tested to [ASTM D4318](#), and gradation within limits specified when tested to [ASTM D422](#) and [ASTM C136/C136M](#): Sieve sizes to [CAN/CGSB-8.2](#).
 - .2 Table:
 - .1

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 - 80
0.005 mm	0 - 45

.3 Coarse grained soils containing more than 20 % by mass passing 0.075 mm sieve.

.8 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.3 REFERENCE STANDARDS

.1 ASTM International (ASTM):

- .1 [ASTM C117- 17](#), Standard Test Method for Material Finer than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing
- .2 [ASTM C136/C136M- 19](#), Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- .3 [ASTM D422-63 2002](#), Standard Test Method for Particle-Size Analysis of Soils
- .4 [ASTM D698- 12](#), Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³)
- .5 [ASTM D1557- 12](#), Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN-m/m³)
- .6 [ASTM D4318- 17e1](#), Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

.2 Canadian General Standards Board (CGSB):

- .1 [CAN/CGSB-8.1-88](#), Sieves, Testing, Woven Wire, Inch Series
- .2 [CAN/CGSB-8.2-M88](#), Sieves, Testing, Woven Wire, Metric

.3 CSA Group (CSA):

- .1 [CAN/CSA-A3000- 18](#), Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005)
 - .1 [CSA-A3001- 18](#), Cementitious Materials for Use in Concrete
- .2 [CSA-A23.1/A23.2- 14](#), Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 00 10 - General Requirements.
- .2 Quality Control: in accordance with Section 01 00 10 - General Requirements:
 - .1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section.
 - .2 Submit for review by Consultant proposed dewatering and heave prevention methods as described in PART 3 of this Section.
 - .3 Submit to Consultant written notice at least 7 days prior to excavation work, to ensure cross sections are taken.
 - .4 Submit to Consultant written notice when bottom of excavation is reached.

- .5 Submit to testing results and report to Consultant as described in PART 3 of this Section.
- .3 Preconstruction Submittals:
 - .1 Submit construction equipment list for major equipment to be used in this section prior to start of Work.
 - .2 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field, clearance record from utility authority, and location plan of relocated and abandoned services, as required.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Inform Consultant at least 4 weeks prior to beginning Work, of proposed source of fillmaterials and provide access for sampling.
 - .3 Submit 70 kg samples of type of fill specified including representative samples of excavated material.
 - .4 Ship samples prepaid to Consultant, in tightly closed containers to prevent contamination and exposure to elements.
 - .5 At least 4 weeks prior to beginning Work, inform Consultantsource of fly ash and submit samples to Consultant.
 - .1 Do not change source of Fly Ash without written approval of Consultant.

1.5 QUALITY ASSURANCE

- .1 Qualification Statement: submit proof of insurance coverage for professional liability.
- .2 Submit design and supporting data at least 2weeks prior to beginning Work.
- .3 Design and supporting data submitted to bear stamp and signature of qualified professional engineer registered or licensed in Yukon Territory, Canada.
- .4 Keep design and supporting data on site.
- .5 Engage services of qualified professional Engineer who is registered or licensed in Yukon Territory, Canada in which Work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for Work.
- .6 Do not use soil material until written report of soil test results are reviewed and approved by Consultant.
- .7 Health and Safety Requirements:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Divert excess aggregatematerials from landfill to local facility for reuse as directed by Consultant.

1.7 EXISTING CONDITIONS

- .1 Examine soil information available in the project specific Geotechnical Report issued by Tetra Tech on January 5, 2023.
- .2 Buried services:

- .1 Before commencing work establish and verify location of buried services on and adjacent to site.
- .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
- .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
- .4 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
- .5 Before beginning excavation Work, notify applicable authorities having jurisdiction establish location and state of use of buried utilities and structures. Contractor to clearly mark such locations to prevent disturbance during Work.
- .6 Confirm locations of buried utilities by careful soil hydrovac methods.
- .7 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered as indicated.
- .8 Where utility lines or structures exist in area of excavation, obtain direction of Consultant before re-routing. Costs for such Work to be paid by Contractor.
- .9 Record location of maintained, re-routed and abandoned underground lines.
- .10 Confirm locations of recent excavations adjacent to area of excavation.
- .3 Existing buildings and surface features:
 - .1 Conduct, with Consultant, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by Work.
 - .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Consultant.
 - .3 Where required for excavation, cut roots or branches in accordance with Section 31 11 00 - Clearing and Grubbing.

Part 2 Products

2.1 MATERIALS

- .1 Compacted Granular Fill: properties to Section 31 05 16 - Aggregate Materials and the following requirements:
 - .1 Bedding sand.
 - .2 Gradations to be within limits specified when tested to [ASTM C136/C136M](#) and [ASTM C117](#). Sieve sizes to [CAN/CGSB-8.2](#).
 - .3 Gradations:
 - .1

Sieve Designation	% Passing
	Bedding Sand
10.0 mm	100
5.0 mm	80 - 100
2.0 mm	55 - 100
0.63 mm	25 - 65
0.25 mm	10 - 40
0.080 mm	2 - 5

- .4 Refer to project specific Geotechnical Report by Tetra Tech issued on December 20, 2022 for supplementary gradation requirements.
- .2 Backfill Material: properties to Section 31 05 16 - Aggregate Materials and the following requirements:
 - .1 80 mm Pit Run Gravel and 20 mm Crushed Basecourse Gravel as per Section 32 11 23 - Aggregate Base Courses.
 - .2 Refer to project specific Geotechnical Report by Tetra Tech issued on December 20, 2022 for supplementary gradation requirements.
- .3 Unshrinkable fill: proportioned and mixed to provide:
 - .1 Maximum compressive strength of 0.4MPa at 28 days.
 - .2 Maximum cement content of 25kg/m³ by volume: to [CSA-A3001](#), Type GU.
 - .3 Minimum strength of 0.07MPa at 24 h.
 - .4 Concrete aggregates: To [CSA-A23.1/A23.2](#)
 - .5 Cement: Type GU.
 - .6 Slump: 160 to 200mm
- .4 Shearmat: Honeycomb type bio-degradable cardboard 100mm thick, treated to provide sufficient structural support for poured concrete until concrete cured.

Part 3 Execution

3.1 SITE PREPARATION

- .1 Remove obstructions, ice, and snow from surfaces to be excavated within limits indicated.
- .2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly in accordance with Section 02 41 13 - Selective Site Demolition.

3.2 PREPARATION/PROTECTION

- .1 Keep excavations clean, free of standing water and loose soil.
- .2 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Consultant approval.
- .3 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
- .4 Protect buried services that are required to remain undisturbed.

3.3 STRIPPING OF TOPSOIL

- .1 Topsoil stripping of areas as indicated in accordance with Section 31 14 13 - Soil Stripping and Stockpiling.
- .2 Stockpile topsoil as indicated in accordance with Section 31 14 13 - Soil Stripping and Stockpiling.

3.4 STOCKPILING

- .1 Stockpile fill materials in areas designated by Consultant.
 - .1 Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.
- .3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.5 COFFERDAMS, SHORING, BRACING AND UNDERPINNING

- .1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Health and Safety Act for the Yukon Territory.
 - .1 Where conditions are unstable, Consultant to verify and advise methods.
- .2 Obtain permit from authority having jurisdiction for temporary diversion of water course.
- .3 Construct temporary Works to depths, heights and locations as indicated.
- .4 During backfill operation:
 - .1 Unless otherwise indicated or directed by Consultant, remove sheeting and shoring from excavations.
 - .2 Do not remove bracing until backfilling has reached respective levels of such bracing.
 - .3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500mm above toe of sheeting.
- .5 When sheeting is required to remain in place, cut off tops at elevations as indicated.
- .6 Upon completion of substructure construction:
 - .1 Remove cofferdams, shoring and bracing.
 - .2 Remove excess materials from site and restore watercourses as directed by Consultant.

3.6 DEWATERING AND HEAVE PREVENTION

- .1 Keep excavations free of water while Work is in progress.
- .2 Provide for Consultant's review details of proposed dewatering or heave prevention methods, including dikes, well points, and sheet pile cut-offs.
- .3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
 - .1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water in runoff areas manner not detrimental to public and private property, or portion of Work completed or under construction.

- .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.
- .6 Provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, watercourses or drainage areas.

3.7 EXCAVATION

- .1 Advise Consultant at least 7 days in advance of excavation operations for initial cross sections to be taken.
- .2 Excavate to lines, grades, elevations and dimensions as indicated.
- .3 Remove concrete, paving, and other obstructions encountered during excavation in accordance with Section 02 41 13 - Selective Site Demolition.
- .4 Excavation must not interfere with bearing capacity of adjacent foundations.
- .5 Do not disturb soil within branch spread of trees or shrubs that are to remain.
 - .1 If excavating through roots, excavate by hand and cut roots with sharp axe or saw.
- .6 For trench excavation, unless otherwise authorized by Consultant in writing, do not excavate more than 30m of trench in advance of installation operations and do not leave open more than 15m at end of day's operation.
- .7 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Consultant.
- .8 Restrict vehicle operations directly adjacent to open trenches.
- .9 Dispose of surplus and unsuitable excavated material off site.
- .10 Do not obstruct flow of surface drainage or natural watercourses.
- .11 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .12 Notify Consultant when bottom of excavation is reached.
- .13 Obtain Consultant approval of completed excavation.
- .14 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Consultant.
- .15 Correct unauthorized over-excavation as follows:
 - .1 Fill under bearing surfaces and footings as outlined in the project specific Geotechnical Report issued by Tetra Tech on January 5, 2023.
- .16 Hand trim, make firm and remove loose material and debris from excavations.
 - .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
 - .2 Clean out rock seams and fill with concrete mortar or grout to approval of Consultant.

3.8 FILL TYPES AND COMPACTION

- .1 Use types of fill as indicated or specified above. Compaction densities are percentages of maximum densities obtained from [ASTM D698](#) and [ASTM D1557](#).

- .1 Class 'B' pipe bedding as detailed in the drawings, compacted to compacted to at least 95% of SPMDD, for depths below 1.0 m from grade and 98% of SPMDD for back fill placed in the final 1.0 m from grade. Pipe bedding and backfill to be placed in 150 mm lifts.
- .2 Exterior side of perimeter walls, within building area, under concrete slabs, and retaining walls: in accordance with the project specific Geotechnical Report issued by Tetra Tech on January 5, 2023.

3.9 BEDDING AND SURROUND OF UNDERGROUND SERVICES

- .1 Place and compact granular material for bedding and surround of underground services as indicated.
- .2 Place bedding and surround material in unfrozen condition.

3.10 BACKFILLING

- .1 Vibratory compaction equipment should be used to achieve the specified compaction for fill materials.
- .2 Do not proceed with backfilling operations until completion of the following:
 - .1 Consultant has inspected and approved installations.
 - .2 Consultant has inspected and approved of construction below finish grade.
 - .3 Inspection, testing, approval, and recording location of underground utilities.
 - .4 Removal of concrete formwork.
 - .5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.
- .3 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
- .4 Do not use backfill material which is frozen or contains ice, snow or debris.
- .5 Place backfill material in uniform layers not exceeding 150mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .6 Backfilling around installations:
 - .1 Place bedding and surround material as specified elsewhere.
 - .2 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
 - .3 Place layers simultaneously on both sides of installed Work to equalize loading. Difference not to exceed 0.5 m.
 - .4 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
 - .1 Permit concrete to cure for minimum 14days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Consultant:
 - .2 If approved by Consultant, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Consultant.
- .7 Place unshrinkable fill in areas as indicated.
- .8 Consolidate and level unshrinkable fill with internal vibrators.

- .9 Install filter system in backfill as indicated.

3.11 RESTORATION

- .1 Upon completion of Work, remove waste materials and debris in accordance to Section 01 00 10 - General Requirements, trim slopes, and correct defects as directed by Consultant.
- .2 Replace topsoil as indicated.
- .3 Reinstall lawns to elevation which existed before excavation.
- .4 Reinstall pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.
- .5 Clean and reinstall areas affected by Work as directed by Consultant.
- .6 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.
- .7 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION

1 GENERAL

1.1 General Requirements

- .1 Refer to Division 1, General Requirements.
- .2 This section of the specification forms an integral part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Description

- .1 Supply all products, labour, equipment, and services necessary to maintain the entire landscape area indicated in the contract documents for two (2) full years, beginning on the date of Acceptance of the entire landscape area.

1.3 Related Work

- .1 Planting of Trees, Shrubs, and Groundcovers – Section 32 92 00
- .2 Sodding – 32 92 23

1.4 Reference Standards

- .1 Work shall meet or exceed the standards and practices as can be typically observed throughout the Yukon University Campus.

1.5 Qualifications

- .1 All work of this Section shall be carried out by fully experienced and licensed maintenance Contractors with current membership standing in the Canadian Landscape & Nursery Association (CLNA). Contractor to have at least 5 years minimum experience working on projects of similar size and scope. Written proof of experience may be requested by Engineer for submission.
- .2 Pesticide/Herbicide/Fungicide and other chemical handling and application shall be done only by applicators holding current certification under the applicable Pesticide Control Act.

1.6 Work Included

- .1 Maintaining the planted areas and the entire landscape area in a weed free condition.
- .2 Fertilizing as specified in this Section.
- .3 Disease and insect control as required to maintain plants in a disease and insect free condition.
- .4 Pruning as specified in this Section.
- .5 Replacement of dead or diseased plants.
- .6 Watering as specified in this Section.
- .8 Protection of the landscape area as necessary.

- .9 Litter removal from the entire landscape and paved areas.
- .10 Soil testing as required to determine fertilizer requirements.
- .11 Planting of seasonal annuals and bulbs.
- .12 Maintain all pedestrian paved surfaces in a clean condition.
- .13 Fall winterization/Spring Start-up of the automatic irrigation system.

1.7 Work Not Included

- .1 Sweeping and cleaning of roadways and parking lots **(except for leaves and landscape debris)**.

1.8 Warranty

- .1 The work of this Section is intended to provide conditions under which the Warranty requirements of Sections 32 92 23 (Sodding) and 32 92 00 (Plants and Planting) can be met through the proper care of grass, plants and planted areas. The requirements of the Warranty shall be the responsibility of this Contractor.

1.9 Equipment

- .1 Equipment shall be suited to the work at hand and shall be in good working condition. All appropriate safety devices shall be in place and functioning to current Federal and Territorial worksite safety requirements.
- .2 All equipment shall be kept clean to prevent spread of diseases. Cutting equipment shall be kept sharp and well adjusted.

1.10 Documentation

- .1 The Contractor shall maintain a logbook of all establishment maintenance operations carried out and shall make the log book available to the Engineer's Inspector for inspection upon request, as may be reasonably required. **Lack of information shall infer non-compliance with the Work of this Section and payment(s) will be adjusted accordingly by the Owner.**
- .2 The Contractor shall submit with each monthly invoice for Work of this Section, a report stating the dates when maintenance staff were on site, the operations carried out and documentation of any conditions requiring attention beyond the Scope of this Section. A sample report is included at the end of this Section.

1.11 Protection and Preservation

- .1 Take all precautions necessary to protect all trees, shrubs, and other plant material; underground and above ground site services, curbs, paving and other services including the irrigation system on and surrounding the contract site against any damage resulting from the work of this Section. Reinstatement to original condition if damaged by the Contractor, his employees, suppliers, sub-trades, or equipment throughout the duration of the contract.

1.12 Codes and Regulations

- .1 All fertilizers shall comply to the Canadian Fertilizer Code.
- .2 All chemicals shall comply and be used as stated under the appropriate Government Code, Law, or Regulation.

1.13 Inspection/Notification

- .1 The Contractor or his authorized representative shall be present during all required inspections.
- .2 Inspections are required at least four times during the year, at times designated by the Landscape Architect.
- .3 Make a written request ten (10) working days before the end of the two-year establishment maintenance period for final inspection.
- .4 At the time of final inspection, all plants and planted areas shall be in the condition specified, all remedial work or replacements shall be complete, and all plants shall be healthy and vigorous.
- .5 Notify the Project Landscape Architect of any physical changes and or discrepancies which may affect the implementation of the contract as specified herein or which may endanger any employee of the Contractor, Consultant, or any member of the general public.
- .6 Provide minimum three (3) days notification in writing prior to application of any chemical vegetation or pest controls. Ensure notices are posted for public safety in entire area of application three (3) days prior and for five (5) days after.

1.14 Scheduling

- .1 Schedule work on site in accordance with weather, soil and plant conditions and use of the site.
- .2 In general, execution involves weekly inspections at least during the growing period (May 1 to October 15) and at least monthly inspections during the remainder of the year, with maintenance operations scheduled on the basis of conditions observed at each inspection.
- .3 Do each operation continuously and complete within a reasonable time period.
- .4 Maintenance personnel shall attend the site during the morning of the first normal working day of each week during the maintenance period. Work at this time shall include litter pick up and disposal, monitoring of moisture in growing medium, and reporting of any damage, deterioration or other conditions requiring attention.

1.15 Payment

- .1 Payment shall consist of equal monthly instalments over the one-year maintenance period.
- .2 Labour shall be designated separately from materials. All billing for materials; mulch, fertilizer, sand, or other materials shall be submitted with receipts of original purchase.

- .3 An up to date log book will be submitted of work done, indicating areas of work, materials used and dates of performance in support of the monthly billing. The logbook shall document the development and condition of plant material as well as preventative and/or corrective measures required which are clearly outside the Contractor's present scope/responsibility. **Failure to submit the logbook in support of the billing will result in a failure to process the payment and may result in non-payment if work cannot be substantiated by the Owner.**

2 PRODUCTS

2.1 General

.1 Product Handling

- .1 Delivery and storage shall be as required such that materials are protected against deterioration or damage as required and such that delivery and storage do not interfere with normal use of the site.

2.2 Plant Material

- .1 Plant material shall meet the requirements of Section 32 92 00, except that new plants supplied under this Section shall be sized to match existing plants of the same variety at the time of installation of new plants.
- .2 Sod or grass seed shall match the varieties installed under Section 32 92 19.

2.3 Water

- .1 Water will be available at no cost to the Contractor. Water source will be determined at time of construction.

2.4 Fertilizers and Limes

- .1 Shall be the following fertilizers and limes with the following guarantee of analysis and used as directed under PART 3 - EXECUTION.
- .1 Fertilizer to meet recommendations of soil analysis provided by construction contract.
- .2 Dolomite of lime (Agrico Spread Easy Dolomite).

2.5 Weed Control and Eradicator Chemicals

- .1 **Do not use any chemical method of insect or disease control without prior written approval of the Project Landscape Architect.** The type of herbicide and application methodology to be submitted in writing to the Owner's Representative for review and approval.
- .2 Use of herbicides, fungicides and insecticides shall conform to all current Yukon University, Municipal, Territorial and Federal Government regulations and codes.

3 EXECUTION

3.1 Plant Material

- .1 Watering:

- .1 Ensure irrigation system is operating properly. Water as required to keep plants and sod in vigorous healthy condition.
- .2 Apply at least 1 to 1-1/2" of water during each application.
- .3 If no irrigation system has been installed, water trees by hand, by soaking the root zone once a week during dry periods. Water source will be as outlined in 2.3
- .2 Weed Control:
 - .1 Maintain all areas in a weed free condition.
 - .2 Inspect landscape areas for weed growth once per week during the growing season and remove all weeds within one week of observing weed growth.
 - .3 Weed control procedures shall have no detrimental effect on the growth of desired plants. Mechanical methods are the preferred methodology in the COV. Confirm with Engineer or Owner's Representative if chemical or other means are to be utilized. **Do not use any chemical method of weed control without prior written approval of the Project Landscape Architect.**
 - .4 Mechanically cut out all grass from around tree pits/saucers to a minimum 600mm dia. to protect all trunks from damage by mowers or trimming equipment.
- .3 Cultivating:
 - .1 In the spring, before beginning watering, cultivate the soil surface of all planted areas including the base of all trees as shallowly as necessary to ensure penetration of water and air into the soil. Repeat as necessary for weed control and soil permeability. In addition, this operation shall be carried out at least twice per month to prevent caking of surface soil or mulch. Where and when applicable mulch should be replaced annually or when required by erosion, decay, cultivation, or vandalism.
 - .2 Avoid cultivating into the root zone of plants.
- .4 Pruning:
 - .1 Deciduous Shrubs: Remove all dead, weak, or diseased wood. Do not clip or shape shrubs - allow the shrub to develop a natural appearance.
 - .2 Trees: Remove dead branches only. All other tree pruning shall be carried out under the direction of the Owner's Representative. Trees improperly pruned and/or not pruned as directed by the Owner's Representative shall be considered as having died and shall be replaced with the same species by the Contractor at no cost to the Owner.
- .5 Pest & Disease Control:
 - .1 **Do not use any chemical method of insect or disease control without prior written approval of the Project Landscape Architect.**
 - .2 Follow a program of Integrated Pest Management using a combination of physical (hosing), cultural, biological and chemical methods chosen for the most effective, safe and economical control of pests and diseases. Minimize pesticide use except where irreversible damage would result from pest and disease infestation.

- .3 Inspect all plants for signs of pest or disease once per week during the growing season and report any such conditions in the monthly report.
 - .4 Begin treatment for pests or diseases immediately following observation. If chemical controls are required, pesticides shall be chosen on the basis of highest effectiveness and selectivity, and least hazard to the environment.
 - .5 Pest and disease control shall be carried out by skilled operators, using methods approved under current laws and regulations.
 - .6 Use the recommended type of equipment and method of application for each chemical as recommended by the chemical manufacturer.
 - .7 All chemicals shall be mixed and applied as stated on the label of the manufacturer.
 - .8 Be extremely cautious in the mixing, handling and application of all chemicals as they may be harmful (if misused) to humans, plants, animals, etc.
 - .9 The Contractor shall be liable for any damage caused through the misuse of any plant disease and/or plant insect control method.
- .6 Fertilizing:
- .1 Two - three (2-3) months after the installation and initial fertilizing of plants (Section 32 92 00), or when directed by Owner's Representative, apply one application of fertilizer appropriate for the time of application and specific for lawns or planting areas at the rates recommended by an approved soil testing laboratory, based on soil test results. Apply a minimum of three applications of fertilizer per annum **for all lawn areas** - April, June and August. Apply a minimum of two applications of fertilizer per annum **for all planting areas** - March and May. Follow manufacturer's recommended application rates, if soils test not taken. Contractor to adjust schedule to meet these requirements per local and seasonal weather conditions.
 - .2 Work the fertilizer thoroughly into the top 50mm of soil.
 - .3 Soil Testing - examine the site to determine any areas where the plant material or lawn is performing poorly. If required and as directed by the Engineer take soil samples from the affected area(s) to an approved soils testing laboratory for soils testing. Costs for such testing shall be borne by the Contractor. Determine the problem. Correct deficiencies to the soil such as poor texture, chemical residues or nutrient level or organic matter deficiencies by appropriate means as recommended by soils testing laboratory. Correct the situation at the appropriate time of year and as coordinated with the Owner's Representative.
- .7 Liming: After threats of frost and within the first year after installation, lime all exterior planting and sod areas with application of dolomite lime at the rate of 10 lbs per 1000 square feet of soil surface, or as otherwise recommended by the soil testing laboratory.
- .8 Tree Protection: All trees shall be protected against wind and snow damage by adequate staking, guying, tying, or wrapping as conditions require. Guys, wire ties and stakes shall conform with Section 32 92 00 and shall be examined at frequent intervals with adjustments or replacements made to prevent any abrasions, cuts, or other damage to the plants.

3.2 Mowing and Trimming

- .1 Mow all lawns with a sharp reel or rotary mower when the grass reaches a height of 60mm (2-1/2 inches). Mow to a height of 40mm (1-1/2 inches); the height of the lawn between cuttings shall not exceed 60mm (2-1/2 inches).
- .2 Trim all edges walks, curbs, mowing strips or planting beds at each mowing with a nylon line type power trimmer to ensure a clean straight edge.
- .3 Remove all excess grass clippings from the grass and planted areas after each mowing, sweep all paving and other surfaces clear of clippings.

3.3 Cleaning of Paved Surfaces

- .1 Maintain all pedestrian paved surfaces of the project in a clean condition. Sweep or hose off all paved surfaces after completing maintenance operations.
- .2 Maintain any sports court surfaces on a weekly basis or as required and directed by Engineer to ensure that leaves or other debris are removed from the court surfaces without damaging any painted or other special surfacing.
- .3 Hose or power wash the surfaces to remove any spills/staining which have occurred on an annual basis. **Ensure that any chemicals or stripping/stain removal agents have been reviewed and approved by Engineer prior to commencing with this work.**

3.4 Clean Up/Litter Removal

- .1 Remove debris, equipment, materials, and waste due to work of this Section at the end of each day of work **from all landscape and pedestrian areas.**
- .2 Keep paved surfaces clear and swept clean of debris, materials and waste from landscaping operations as required throughout the year.
- .3 Remove leaves and landscape debris from all paved vehicular roadways and parking lots.
- .4 **SPRING CLEAN-UP** - remove all debris from lawn areas, shrub and flower beds including vegetative debris or growing medium from all pedestrian paved surfaces. Cultivate all planting beds and tree pits to requirements of 3.1.3.
- .5 **FALL CLEAN-UP** - Fall clean-up includes the same operations as specified for the Spring plus disposal of leaves from the entire site. Review the site weekly through the Fall and ensure operations are completed by end of September (or as dictated by Owner's Representative).

3.7 Sample Landscape Maintenance Report

- .1 Following is a single page sample landscape maintenance report.

LANDSCAPE MAINTENANCE MONTHLY REPORT (sample)

Project Name/Contract No.: _____
 Owner's Representative _____
 Date: _____ Time: _____ Weather _____
 Contractor Foreman _____
 Month: _____ Size of Crew: _____

<i>Elements</i>	<i>Work completed</i>	<i>Problems requiring attention</i>
BEDDING PLANTS -cultivation/weeding -fertilization -moisture content -seasonal change		
SHRUBS & GROUNDCOVERS -cultivation/weeding -pest and disease -fertilization -replace dead/dying material -weed control -pruning/moisture content		
TREES/ MAJOR PLANTS -pruning dead/broken branches -fertilization -replace dead/dying material -check/adjust guying/stakes -weed control -moisture content		
LAWN AREAS -mowing/edge trimming -moisture content -fertilization -weed control		
PAVED/GRAVELED/ BARE AREAS -general review -special maintenance/cleaning req'd.		
GENERAL COMMENTS/OTHER OBSERVATIONS -irrigation system component check -irrigation winterization/start-up -overly dry or too wet conditions		

END OF SECTION 32 01 90

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 05 16 - Aggregate Materials

1.2 REFERENCE STANDARDS

- .1 ASTM International (ASTM):
 - .1 [ASTM C117- 17](#), Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing
 - .2 [ASTM C131/C131M- 20](#), Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - .3 [ASTM C136/C136M- 19](#), Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - .4 [ASTM D698- 12](#), Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³) (600kN-m/m³)
 - .5 [ASTM D1557- 12](#), Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft³) (2,700kN-m/m³)
 - .6 [ASTM D1883- 16](#), Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils
 - .7 [ASTM D4318- 17el](#), Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils
- .2 Canadian General Standards Board (CGSB):
 - .1 [CAN/CGSB-8.1-88](#), Sieves, Testing, Woven Wire, Inch Series
 - .2 [CAN/CGSB-8.2-M88](#), Sieves, Testing, Woven Wire, Metric

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 31 05 16 - Aggregate Materials.
- .2 Storage and Handling Requirements:
 - .1 Store materials in clean dry location and in accordance with manufacturer's recommendations.

Part 2 Products

2.1 MATERIALS

- .1 Granular base: material in accordance with Section 31 05 16 - Aggregate Materials and the following requirements:
 - .1 Crushed stone or gravel.
 - .2 Gradations to be within limits specified when tested to [ASTM C117](#) or [ASTM C136/C136M](#). Sieve sizes to [CAN/CGSB-8.2](#).

.1 Gradations:

.1

Sieve Designation	% Passing	Sieve Designation	% Passing
	80 mm Pit Run Gravel		20 mm Crushed Basecourse Gravel
80.0 mm	100	-	
25.0 mm	55 - 100	20 mm	100
12.5 mm	42 - 84	12.5 mm	64 - 100
5.00 mm	26 - 65	5.00 mm	36 - 72
1.25 mm	11 - 47	1.25 mm	12 - 42
0.315 mm	3 - 30	0.315 mm	4 - 22
0.080 mm	0 - 8	0.080 mm	3 - 6

.2 Refer to project specific Geotechnical Report by Tetra Tech issued on January 5, 2023 for supplementary gradation requirements.

Part 3 Execution**3.1 PLACEMENT AND INSTALLATION**

- .1 Place granular base after subgrade surface is inspected and approved in writing by Consultant.
- .2 Placing:
 - .1 Construct granular base to depth and grade in areas indicated.
 - .2 Ensure no frozen material is placed.
 - .3 Place material only on clean unfrozen surface, free from snow and ice.
 - .4 Begin spreading base material on crown line or on high side of one-way slope.
 - .5 Place material using methods which do not lead to segregation or degradation of aggregate.
 - .6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
 - .7 Place material to full width in uniform layers not exceeding 150mm compacted thickness.
 - .1 Consultant may authorize thicker lifts (layers) if specified compaction can be achieved.
 - .8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
 - .9 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .3 Compaction Equipment:
 - .1 Ensure compaction equipment is capable of obtaining required material densities.

- .2 Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from Consultant before use.
- .3 Equipped with device that records hours of actual work, not motor running hours.
- .4 Compacting:
 - .1 Compact to density not less than 100 % maximum dry density to [ASTM D698](#).
 - .2 Compact to density not less than to percentages of maximum dry density to [ASTM D698](#) as outlined in the project specific Geotechnical Report issued by Tetra Tech on January 5, 2023.
 - .3 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
 - .4 Apply water as necessary during compacting to obtain specified density.
 - .5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved in writing by Consultant.
 - .6 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.
- .5 Proof rolling:
 - .1 For proof rolling use standard roller of 45 400kg gross mass with four pneumatic tires each carrying 11 350kg and inflated to 620kPa. Four tires arranged abreast with centre to centre spacing of 730mm.
 - .2 Obtain written approval from Consultant to use non standard proof rolling equipment.
 - .3 Proof roll at level in granular base as indicated.
 - .1 If use of non standard proof rolling equipment is approved, Consultant to determine level of proof rolling.
 - .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
 - .5 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove base, sub-base and subgrade material to depth and extent as directed by Consultant.
 - .2 Backfill excavated subgrade with base material and compact in accordance with this section.
 - .6 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Consultant and replace with new materials in accordance with this section at no extra cost.

3.2 SITE TOLERANCES

- .1 Finished base surface to be within plus or minus 10mm of established grade and cross section but not uniformly high or low.

3.3 CLEANING

- .1 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment .
- .2 Waste Management: Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

- .1 Divert unused granular material from landfill to local facility approved by Consultant.

3.4 PROTECTION

- .1 Maintain finished base in condition conforming to this Section until succeeding material is applied or until acceptance by Consultant.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 32 12 16 - Asphalt paving.

1.2 REFERENCE STANDARDS

- .1 American Association of State Highway and Transportation Officials (AASHTO)
 - .1 [AASHTO T245-97-UL-2004](#), Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
- .2 Ministry of Transportation Ontario (MTO)
 - .1 MTO Laboratory Testing Manual-09: LS-283, Resistance to Stripping of Asphalt Cement in Bituminous Mixtures by Immersion Marshall.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Samples:
 - .1 Submit 2 samples of each proposed asphalt paving mixture.

Part 2 Products

2.1 MATERIALS

- .1 Representative samples of each asphalt paving mixture proposed for use on Project.

2.2 EQUIPMENT

- .1 One or more water baths with automatic controls for immersing specimens. Baths normally used for Marshall Immersion Test are suitable for test.
- .2 Scale and water bath with suitable accessory equipment for weighing test specimens in air and in water to determine their densities.
- .3 Flat transfer plates of glass or metal. Keep 1 plate under each specimen during immersion period and during subsequent handling, except when weighing and testing, to prevent breakage or distortion of specimens.
- .4 Apparatus required to conduct Marshall Immersion Test.

Part 3 Execution

3.1 PREPARATION

- .1 Prepare at least 8 specimens for each test with hand-operated hammer, in accordance with [AASHTO T245-97-UL](#) or LS-283, except where specified otherwise.

3.2 TEST PROCEDURE

- .1 Do Marshall testing to [AASHTO T245-97-UL](#) or LS-283.
- .2 Weigh each specimen in air and in water. Weigh in water as rapidly as possible to minimize absorption.
- .3 Calculate specific gravity of each specimen as follows:

- .1 Specific Gravity = $A / (A - B)$
- .2 Where A = weight of specimen in air in grams
- .3 B = weight of specimen in water in grams
- .4 Sort each set of 8 specimens into 2 groups of 4 specimens each so that average specific gravity of specimens in group 1 is essentially same as that of group 2.
- .5 Test group 1 specimens for Marshall stability. Calculate S1 = Marshall stability of group 1 (average).
- .6 Immerse group 2 specimens in water for 24 hours at 60 degrees C, then test immediately for Marshall stability. Calculate S2 = Marshall stability of group 2 (average).

3.3 CLOSEOUT ACTIVITIES

- .1 Report test results to Consultant.
- .2 Report numerical index of retained stability as resistance of asphaltic paving mixtures to detrimental effect of water, expressed as percentage of original stability retained after immersion period.
- .3 Calculate index as follows:
 - .1 Index of Retained Stability = $S2 / S1 \times 100$.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 02 41 13 - Selective Site Demolition
- .2 Section 32 12 10 - Marshall Immersion Test for Bitumen

1.2 REFERENCE STANDARDS

- .1 American Association of State Highway and Transportation Officials (AASHTO):
 - .1 [AASHTO M320- 21](#), Standard Specification for Performance Graded Asphalt Binder
 - .2 [AASHTO R29- 15](#), Standard Specification for Grading or Verifying the Performance Graded of an Asphalt Binder
 - .3 [AASHTO T245- 15](#), Standard Method of Test for Resistance to Plastic flow of Bituminous Mixtures Using Marshall Apparatus
- .2 Asphalt Institute (AI):
 - .1 AI MS-2- Sixth Edition, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types
- .3 ASTM International (ASTM):
 - .1 [ASTM C88/C88M- 18](#), Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate
 - .2 [ASTM C117- 17](#), Standard Test Method for Material Finer Than 0.075mm (No.200) Sieve in Mineral Aggregates by Washing
 - .3 [ASTM C123/C123M- 14](#), Standard Test Method for Lightweight Particles in Aggregate
 - .4 [ASTM C127- 15](#), Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate
 - .5 [ASTM C128- 15](#), Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
 - .6 [ASTM C131/C141M- 20](#), Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - .7 [ASTM C136/C136M- 19](#), Standard Method for Sieve Analysis of Fine and Coarse Aggregates
 - .8 [ASTM C207- 18](#), Standard Specification for Hydrated Lime for Masonry Purposes
 - .9 [ASTM D995-95b](#), Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
 - .10 [ASTM D2419- 14](#), Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
 - .11 [ASTM D3203/C3203M- 17](#), Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
 - .12 [ASTM D4791- 19](#), Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
- .4 Canadian General Standards Board (CGSB):

- .1 [CAN/CGSB-8.1-88](#), Sieves Testing, Woven Wire, Inch Series
- .2 [CAN/CGSB-8.2-M88](#), Sieves Testing, Woven Wire, Metric

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for asphalt mixes and aggregate and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit viscosity-temperature chart for asphalt cement to be supplied showing either Saybolt Furol viscosity in seconds or Kinematic Viscosity in centistokes, temperature range 105 to 175 degrees C 4weeks before beginning work.
- .3 Samples:
 - .1 Inform Consultant of proposed source of aggregates and provide access for sampling 4weeks before beginning work.
 - .2 Submit samples of the following materials proposed for use 4 weeks before beginning work.
 - .1 One 5L container of asphalt cement.
 - .2 1kg of hydrated lime.
- .4 Test and Evaluation Reports:
- .5 Certificates:
 - .1 Certification to be marked on pipe.
- .6 Test and Evaluation Reports:
 - .1 Submit manufacturer's test data and certification that asphalt cement meets specification requirements.
 - .2 Submit manufacturer's test data and certification that hydrated lime meets specified requirements.
 - .3 Submit asphalt concrete mix design and trial mix test results to Consultant for review.
 - .4 Submit printed record of mix temperatures at end of each day.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Manufacturer's recommendations.
- .2 Deliver and stockpile aggregates in accordance with erosion and sedimentation control plan.
- .3 When necessary to blend aggregates from one or more sources to produce required gradation, do not blend in stockpiles.
- .4 Stockpile fine aggregate separately from coarse aggregate, although separate stockpiles for more than two mix components are permitted.
- .5 Provide approved storage, heating tanks and pumping facilities for asphalt cement.
- .6 Submit to Consultant copies of freight and waybills for asphalt cement as shipments are received.

- .1 Consultant reserves right to check weights as material is received.
- .7 Stockpile crushed RAP separately in accordance with Section 31 05 16 - Aggregate Materials as indicated.
- .8 Protect and cover stockpiles of crushed RAP from rain to approval of Consultant in accordance with erosion and sedimentation control plan.

Part 2 Products

2.1 MATERIALS

- .1 Aggregates: in accordance with [31 05 16 - Aggregate Materials General] requirements as follows:
 - .1 Crushed stone or gravel.
 - .2 Gradations: within limits specified when tested to [ASTM C136/C136M](#) and [ASTM C117](#). Sieve sizes to [CAN/CGSB-8.2](#).
 - .3 Table:
 - .1

Sieve Designation	% Passing	
	Roads	
12.5 mm	100	
5.00 mm	55-75	
2.00 mm	35-55	
0.425 mm	15-30	
0.180 mm	5-20	
0.075 mm	3-8	

- .4 Do not use aggregates having known polishing characteristics in mixes for surface courses.
- .5 Regardless of compliance with specified physical requirements, fine aggregates may be accepted or rejected on basis of past field performance.

2.2 EQUIPMENT

- .1 Pavers: Mechanical grade controlled self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown indicated.
- .2 Rollers: Sufficient number of type and weight to obtain specified density of compacted mix.
- .3 Vibratory rollers:
 - .1 Drum diameter: 1200mm minimum.
 - .2 Amplitude of vibration (machine setting): 0.5mm maximum for lifts less than 40 mm thick.
- .4 Haul trucks: Sufficient number and of adequate size, speed and condition to ensure orderly and continuous operation and as follows:
 - .1 Boxes with tight metal bottoms.
 - .2 Covers of sufficient size and weight to completely cover and protect asphalt mix when truck fully loaded.
 - .3 In cool weather or for long hauls, insulate entire contact area of each truck box.

- .4 Use only trucks which can be weighed in single operation on scales supplied.
- .5 Hand tools:
 - .1 Lutes or rakes with covered teeth for spreading and finishing operations.
 - .2 Tamping irons having mass 12 kg minimum and bearing area not exceeding 310 cm² for compacting material along curbs, gutters and other structures inaccessible to roller. Mechanical compaction equipment, when approved by Consultant, may be used instead of tamping irons.
 - .3 Straight edges, 4.5m in length, to test finished surface.
- .6 Plant testing facility: provide laboratory space at plant site for exclusive use of Consultant, for performing tests, keeping records and making reports.

2.3 MIX DESIGN

- .1 Mix design to be approved in writing by Consultant.
- .2 Mix design to be developed by testing laboratory approved in writing by Consultant.
- .3 Design of mix: by Marshall method to requirements below.
 - .1 Compaction blows on each face of test specimens: 50.
 - .2 Mix physical requirements:
 - .1

Property	Roads
Aggregate size, mm max	12.5
Marshall Stability at 60 degrees C kN min	5.5
Flow Value, mm	2-4
Air Voids in Mixture, %	3-5
Voids in Mineral Aggregate, % min	15
Index of Retained Stability, % min	75

- .3 Measure physical requirements as follows:
 - .1 Marshall load and flow value: to [AASHTO T245](#).
 - .2 Compute void properties on basis of bulk specific gravity of aggregate to [ASTM C127](#) and [ASTM C128](#). Make allowance for volume of asphalt absorbed into pores of aggregate.
 - .3 Air voids: To [ASTM D3203/D3203M](#).
 - .4 Voids in mineral aggregates: To MS2.
 - .5 Index of Retained Stability: Measure in accordance with Section 32 12 10 - Marshall Immersion Test for Bitumen.
- .4 Do not change job-mix without prior approval of Consultant. When change in material source proposed, new job-mix formula to be reviewed by Consultant.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for asphalt paving in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 PLANT AND MIXING REQUIREMENTS

- .1 Batch and continuous mixing plants:
 - .1 To [ASTM D995](#).
 - .2 Feed aggregates from individual stockpiles through separate bins to cold elevator feeders.
 - .1 Do not load frozen materials into bins.
 - .3 Feed cold aggregates to plant in proportions to ensure continuous operations.
 - .4 Calibrate bin gate openings and conveyor speeds to ensure mix proportions are achieved.
 - .5 Before mixing, dry aggregates to moisture content not greater than 1 % by mass or to lesser moisture content if required to meet mix design requirements. .
 - .6 Immediately after drying, screen aggregates into hot storage bins in sizes to permit recombining into gradation meeting job-mix requirements.
 - .7 Store hot screened aggregates in manner to minimize segregation and temperature loss.
 - .8 Heat asphalt cement and aggregate to mixing temperature directed by Consultant. Do not heat asphalt cement above maximum temperature indicated on temperature-viscosity chart.
 - .9 Make available current asphalt cement viscosity data at plant. With information relative to viscosity of asphalt being used, Consultant to review temperature of completed mix at plant and at paver after considering hauling and placing conditions.
 - .10 Maintain temperature of materials within 5degrees C of specified mix temperature during mixing.
 - .11 Mixing time:
 - .1 In batch plants, both dry and wet mixing times as directed by Consultant. Continue wet mixing as long as necessary to obtain thoroughly blended mix but not less than 30s or more than 75s.
 - .2 In continuous mixing plants, mixing time as directed by Consultant but not less than 45s.
 - .3 Mixing time as directed by Consultant.
- .2 Dryer drum mixing plant:
 - .1 To [ASTM D995](#).
 - .2 Load aggregates from individual stockpiles to separate cold feed bins. Do not load frozen materials into bins.
 - .3 Feed aggregates to burner end of dryer drum by means of multi-bin cold feed unit and blend to meet job-mix requirements by adjustments of variable speed feed belts and gates on each bin.

- .4 Meter total flow of aggregate using electronic weigh belt system with indicator that can be monitored by plant operator and which is interlocked with asphalt pump to ensure proportions of aggregate, and asphalt entering mixer remain constant.
- .5 Allow for easy calibration of weighing systems for aggregates without having material enter mixer.
- .6 Calibrate bin gate openings and conveyor speeds to ensure mix proportions are achieved.
 - .1 Calibrate weigh bridge on charging conveyor by weighing amount of aggregate passing over weigh bridge in set amount of time.
 - .2 Difference between this value and amount shown by plant computer system to differ by not more than plus or minus 2 %.
- .7 Make provision for conveniently sampling full flow of materials from cold feed.
- .8 Provide screens or other suitable devices to reject oversize particles or lumps of aggregate from cold feed before entering drum.
- .9 Provide system interlock stop on feed components if either asphalt or aggregate from bin stops flowing.
- .10 Accomplish heating and mixing of asphalt mix in approved parallel flow dryer-mixer in which aggregate enters drum at burner end and travels parallel to flame and exhaust gas stream.
 - .1 Control heating to prevent fracture of aggregate or excessive oxidation of asphalt.
 - .2 Equip system with automatic burner controls and provide for continuous temperature sensing of asphalt mixture at discharge, with printing recorder that can be monitored by plant operator.
 - .3 Submit printed record of mix temperatures at end of each day.
- .11 Ensure mixing period and temperature to produce uniform mixture in which particles are thoroughly coated, and moisture content of material as it leaves mixer is 2 % maximum.
- .3 Temporary storage of hot mix:
 - .1 Provide mix storage of sufficient capacity to permit continuous operation and designed to prevent segregation.
 - .2 Do not store asphalt mix in storage bins in excess of 3hour.
- .4 While producing asphalt mix for this Project, do not produce mix for other users unless separate storage and pumping facilities are provided for materials supplied to this project.
- .5 Mixing tolerances:
 - .1 Permissible variation in aggregate gradation from job mix (percent of total mass).
 - .1

4.75 mm sieve and larger	5
2.00 mm sieve	4
0.425 mm sieve	2
0.180 mm sieve	2
0.075 mm sieve	2

- .2 Permissible variation of asphalt cement from job mix: 0.25%.

- .3 Permissible variation of mix temperature at discharge from plant: 5degrees C.
- .6 Addition of anti-stripping agent:
 - .1 Plant to be equipped with pug mill to thoroughly mix aggregates and lime before entering the plant.
 - .2 Plant to be equipped with suitable conveyor systems capable of supplying aggregates and lime at constant rate.
 - .3 Plant and equipment used for addition of lime to be equipped with covers to control loss of lime.
 - .4 Plant to be equipped to control rate of lime incorporation to within 1/4%.
 - .5 Add water to aggregate before entering pug mill.
 - .6 Add water to lime sufficiently in advance to permit time to slake before entering pug mill.

3.3 PREPARATION

- .1 Before laying mix, clean surfaces of loose and foreign material.

3.4 WEATHER LIMITATIONS

- .1 Mixture shall not be placed:
 - .1 During periods of rain or when rain is imminent.
 - .2 When frost and or frozen ground is present on the surface.

3.5 TRANSPORTATION OF MIX

- .1 Transport mix to job site in vehicles cleaned of foreign material.
- .2 Paint or spray truck beds with limewater, soap or detergent solution, or non petroleum based commercial product, at least daily or as required.
 - .1 Raise truck bed and thoroughly drain, and ensure no excess solution remains in truck bed.
- .3 Schedule delivery of material for placing in daylight, unless Consultant approves artificial light for night placing.
- .4 Deposit mix from surge or storage silo to trucks in multiple drops to reduce segregation.
 - .1 Do not dribble mix into trucks.
- .5 Deliver material to paver at uniform rate and in an amount within capacity of paving and compacting equipment.
- .6 Deliver loads continuously in covered vehicles and immediately spread and compact.
 - .1 Deliver and place mixes at temperature within range as directed by Consultant, but not less than 135 degrees C.

3.6 PLACING

- .1 Obtain Consultant's approval of existing surface before placing asphalt.
- .2 Place asphalt concrete to thicknesses, grades and lines as indicated.
- .3 Placing conditions:
 - .1 Place asphalt mixtures only when air temperature is 2 degrees C minimum.

- .2 When temperature of surface on which material is to be placed falls below 10 degrees C, provide extra rollers as necessary to obtain required compaction before cooling.
- .3 Do not place hot-mix asphalt when pools of standing water exist on surface to be paved, during rain, or when surface is damp.
- .4 Do not place during periods of rain or when rain is imminent.
- .5 Do not place when frost or frozen ground is present on the surface to be paved.
- .4 Place asphalt concrete in compacted lifts of thickness as indicated and as follows.
 - .1 Roads and parking lots required single lift thickness of 75 mm.
- .5 Place individual strips no longer than 500m.
- .6 Spread and strike off mixture with self propelled mechanical finisher.
 - .1 Construct longitudinal joints and edges true to line markings.
 - .1 Contractor to establish lines for paver to follow parallel to centerline of proposed pavement. Position and operate paver to follow established line closely.
 - .2 When using pavers in echelon, have first paver follow marks or lines, and second paver follow edge of material placed by first paver.
 - .1 Work pavers as close together as possible and in no case permit them to be more than 30m apart.
 - .3 Maintain constant head of mix in auger chamber of paver during placing.
 - .4 If segregation occurs, immediately suspend spreading operation until cause is determined and corrected.
 - .5 Correct irregularities in alignment left by paver by trimming directly behind machine.
 - .6 Correct irregularities in surface of pavement course directly behind paver.
 - .1 Remove excess material forming high spots using shovel or lute.
 - .1 Fill and smooth indented areas with hot mix.
 - .2 Do not broadcast material over such areas.
 - .7 Do not throw surplus material on freshly screeded surfaces.
- .7 When hand spreading is used:
 - .1 Use approved wood or steel forms, rigidly supported to assure correct grade and cross section.
 - .1 Use measuring blocks and intermediate strips to aid in obtaining required cross-section.
 - .2 Distribute material uniformly without broad casting material.
 - .3 During spreading operation, thoroughly loosen and uniformly distribute material by lutes or covered rakes.
 - .1 Reject material that has formed into lumps and does not break down readily.
 - .4 After placing and before rolling, check surface with templates and straightedges and correct irregularities.
 - .5 Provide heating equipment to keep hand tools free from asphalt.

- .1 Control temperature to avoid burning material.
- .2 Do not use tools at higher temperature than temperature of mix being placed.

3.7 COMPACTING

- .1 Do not change rolling pattern unless mix changes or lift thickness changes.
 - .1 Change rolling pattern only as directed by Consultant.
- .2 Roll asphalt continuously to density not less than 98 % of standard laboratory blow Marshall density to [AASHTO T245](#).
- .3 General:
 - .1 Provide at least 2 rollers and as many additional rollers as necessary to achieve specified pavement density. When more than 2 rollers are required, 1 roller must be pneumatic tired type.
 - .2 Start rolling operations as soon as placed mix can bear weight of roller without excess displacement of material or cracking of surface.
 - .3 Operate roller slowly initially to avoid displacement of material. Do not exceed 5km/h for breakdown and intermediate rolling for static steel-wheeled and pneumatic tired rollers. Do not exceed 9km/h for finish rolling.
 - .4 Use static compaction for levelling coarse less than 25 mm thick.
 - .5 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of 25 impacts per metre of travel. For lifts less than 50 mm thick, impact spacing not to exceed compacted lift thickness.
 - .6 Overlap successive passes of roller by minimum of 200mm and vary pass lengths.
 - .7 Keep wheels of roller slightly moistened with water to prevent pick-up of material but do not over-water.
 - .8 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.
 - .9 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.
 - .10 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side.
 - .1 Ensure that all points across width of pavement receive essentially equal numbers of passes of compactors.
 - .11 When paving in echelon, leave unrolled 50 to 75 mm of edge which second paver is following and roll when joint between lanes is rolled.
 - .12 Where rolling causes displacement of material, loosen affected areas at once with lutes or shovels and restore to original grade of loose material before re-rolling.
- .4 Breakdown rolling:
 - .1 Begin breakdown rolling with static steel wheeled roller immediately following rolling of transverse and longitudinal joint and edges.
 - .2 Operate rollers as close to paver as necessary to obtain adequate density without causing undue displacement.

- .3 Operate breakdown roller with drive roll or wheel nearest finishing machine. When working on steep slopes or super-elevated sections use operation approved by Consultant.
- .4 Use only experienced roller operators.
- .5 Intermediate rolling:
 - .1 Use pneumatic-tired, steel wheel or vibratory rollers and follow breakdown rolling as closely as possible and while paving mix temperature allows maximum density from this operation.
 - .2 Rolling to be continuous after initial rolling until mix placed has been thoroughly compacted.
- .6 Finish rolling:
 - .1 Accomplish finish rolling with two-axle or three-axle tandem steel wheeled rollers while material is still warm enough for removal of roller marks.
 - .1 If necessary to obtain desired surface finish, use pneumatic-tired rollers as directed by Consultant.
 - .2 Conduct rolling operations in close sequence.
- .7 Dust entire area of sheet asphalt pavements with hydrated lime immediately after rolling to eliminate tendency to pick-up under traffic.

3.8 JOINTS

- .1 General:
 - .1 Remove surplus material from surface of previously laid strip.
 - .1 Do not deposit on surface of freshly laid strip.
 - .2 Construct joints between asphalt concrete pavement and Portland cement concrete pavement as indicated.
 - .3 Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material before placing adjacent pavement.
- .2 Transverse joints:
 - .1 Offset transverse joint in succeeding lifts by at least 600mm.
 - .2 Cut back to full depth vertical face and tack face with thin coat of hot asphalt before continuing paving.
 - .3 Compact transverse joints to provide smooth riding surface. Use methods to prevent rounding of compacted surface at joints.
- .3 Longitudinal joints:
 - .1 Offset longitudinal joints in succeeding lifts by at least 150mm.
 - .2 Cold joint is defined as joint where asphalt mix is placed, compacted and left to cool below 100 degrees C before paving of adjacent lane.
 - .1 For airfield runway paving, avoid cold joint construction in mid 30 m of runway.
 - .2 If cold joint can not be avoided, cut back by saw cutting previously laid lane, by at least 150 mm, to full depth vertical face, and tack face with thin coat of hot asphalt of adjacent lane.
 - .3 Overlap previously laid strip with spreader by 25 to 50mm.

- .4 Before rolling, carefully remove and discard coarse aggregate in material overlapping joint with lute or rake.
- .5 Roll longitudinal joints directly behind paving operation.
- .6 When rolling with static or vibratory rollers, have most of drum width ride on newly placed lane with remaining 150 mm extending onto previously placed and compacted lane.
- .4 Construct feather joints so that thinner portion of joint contains fine graded material obtained by changed mix design or by raking out coarse aggregate in mix.
 - .1 Place and compact joint to ensure joint is smooth and without visible breaks in grade.
 - .2 Locate feather joints as indicated.
- .5 Construct butt joints as indicated.

3.9 FINISH TOLERANCES

- .1 Finished asphalt surface to be within 5mm of design elevation but not uniformly high or low.
- .2 Finished asphalt surface not to have irregularities exceeding 5mm when checked with 4.5m straight edge placed in any direction.

3.10 DEFECTIVE WORK

- .1 Correct irregularities which develop before completion of rolling by loosening surface mix and removing or adding material as required.
 - .1 If irregularities or defects remain after final compaction, remove surface course promptly and lay new material to form true and even surface and compact immediately to specified density.
- .2 Repair areas showing checking, rippling, or segregation.
- .3 Adjust roller operation and screed settings on paver to prevent further defects such as rippling and checking of pavement.

3.11 CLEANING

- .1 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment,
- .2 Waste Management: Separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 20 00.50 - Concrete Reinforcing - Civil
- .2 Section 03 30 00.50 - Cast-in-Place Concrete - Civil
- .3 Section 31 05 16 - Aggregate Materials
- .4 Section 31 23 33.01 - Excavating, Trenching and Backfilling

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 [ASTM C117-13](#), Standard Test Method for Materials Finer than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 [ASTM C136/C136M-14](#), Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 [ASTM C 309 03](#), Liquid Membrane Forming Compounds for Curing Concrete.
 - .4 [ASTM D1751](#), Standard Specification For Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - .5 [ASTM D698-12e2](#), Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³) (600 kN-m/m³).
- .2 CSA Group
 - .1 [CSA-A23.1-14/A23.2-](#), Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete, Including Update No. 1 2015.
 - .2 [CSA B651-2012](#) Accessible Design for the Built Environment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, and limitations.
- .3 Inform Consultant of proposed source of materials and provide access for sampling minimum 4 weeks prior to commencing work.
- .4 If materials have been tested by accredited testing laboratory testing laboratory approved by Consultant within previous 2 months and have passed tests equal to requirements of this specification, submit test certificates from testing laboratory showing suitability of materials for this project.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Concrete mixes and materials: in accordance with Section 03 30 00.50 - Cast-in-Place Concrete - Civil.
- .2 Reinforcing steel: in accordance with Section 03 20 00.50 - Concrete Reinforcing - Civil.
- .3 Curing Compound: in accordance with Section 03 30 00.50 - Cast-in-Place Concrete - Civil.
- .4 Granular base: material to Section 31 05 16 - Aggregate Materials and Section 32 11 23 - Aggregate Base Courses following requirements:
 - .1 Crushed stone or gravel.
 - .2 Gradations: within limits specified when tested to [ASTM C136](#) and [ASTM C117](#).
- .5 Non-staining mineral type form release agent: chemically active release agents containing compounds reacting with free lime to provide water-soluble soap.
- .6 Fill material: to Section 31 05 16 - Aggregate Materials and Section 32 11 23 - Aggregate Base Courses following requirements:
 - .1 Crushed stone or gravel.
 - .2 Gradations: within limits specified when tested to [ASTM C136](#) and [ASTM C117](#). Sieve sizes to [CAN/CGSB-8.1](#)
- .7 Curing Agent: to [ASTM C309](#), Type 1
- .8 Expansion Joint Filler: Premoulded bituminous fibre board, conforming to [ASTM D1751](#)
- .9 Tactile Walking Surface Indicators: Cast iron with truncated domes to [CSA B651](#)

Part 3 Execution

3.1 GRADE PREPARATION

- .1 Do grade preparation work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Construct embankments using excavated material free from organic matter or other objectionable materials.
 - .1 Dispose of surplus and unsuitable excavated material off site.
- .3 When constructing embankment provide for minimum 3 m shoulders, where applicable, outside of neat lines of concrete.
- .4 Place fill in maximum 150 mm layers and compact to minimum 98% of maximum dry density to [ASTM D698](#)

3.2 GRANULAR BASE

- .1 Obtain Consultant's approval of subgrade before placing granular base.
- .2 Place granular base material to lines, widths, and depths as indicated.
- .3 Compact granular base in maximum 150 mm layers to minimum 98% of maximum density to [ASTM D698](#)

3.3 CONCRETE

- .1 Obtain Consultant's approval of granular base and reinforcing steel prior to placing concrete.
- .2 Reinforcing steel rods and wire mesh as per City of Whitehorse Servicing Standards Manual - Section 4 Standard Details
- .3 All sidewalks, aprons, and exterior slabs with a width greater than 1.5m shall be reinforced with a minimum 150x150 P8/8 Gauge Welded Wire Mesh.
- .4 Do concrete work in accordance with Section 03 30 00.50 - Cast-in-Place Concrete - Civil.
- .5 Immediately after floating, give sidewalk surface uniform broom finish to produce regular corrugations not exceeding 2 mm deep, by drawing broom side to side across sidewalk.
- .6 Provide edging as indicated with 10 mm radius edging tool.
- .7 Slip-form pavers equipped with string line system for line and grade control may be used if quality of work acceptable to Consultant can be demonstrated. Hand finish surfaces when directed by Consultant.

3.4 TOLERANCES

- .1 Finish surfaces to within 3 mm in 3 m as measured with 3 m straightedge placed on surface.

3.5 EXPANSION AND CONTRACTION JOINTS

- .1 Install tooled transverse contraction joints after floating, when concrete stiff, but still plastic, at intervals of 3 m.
- .2 Install expansion joints as directed by Consultant.
- .3 When sidewalk adjacent to curb, make joints of curb, gutters and sidewalk coincide.
- .4 Joint filler is to conform to CGSB Standard Specification for polyurethane sealing compound #19-GP-15 or ASTM Standard Specification for SIKA FLEX 1A.
- .5 Preformed expansion joint filler is to conform to ASTM Standard Specification D-1752.

3.6 ISOLATION JOINTS

- .1 Install isolation joints around manholes and catch basins and along length adjacent to concrete curbs, catch basins, buildings, or permanent structure.
- .2 Install joint filler in isolation joints in accordance with Section 03 30 00.50 - Cast-in-Place Concrete - Civil.
- .3 Seal isolation joints with sealant approved by Consultant.

3.7 TACTILE WALKING SURFACE INDICATORS

- .1 Install tactile walking surface indicators at curb ramp edges, where indicated on drawings and in accordance with local municipal by-laws.

3.8 CURING

- .1 Cure concrete by adding moisture continuously in accordance with [CSA-A23.1/A23.2](#) to exposed finished surfaces for minimum 1 day after placing, or sealing moisture in by curing compound as directed by Consultant.

- .2 Where burlap used for moist curing, place two prewetted layers on concrete surface and keep continuously wet during curing period.
- .3 Apply curing compound evenly to form continuous film, in accordance with manufacturer's requirements.

3.9 BACKFILL

- .1 Allow concrete to cure for 7 days prior to backfilling.
- .2 Backfill to designated elevations with material as directed by Consultant.
 - .1 Compact and shape to required contours as indicated.

3.10 CLEANING

- .1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International
 - .1 [ASTM E1360](#) 90 2000 e1, Standard Practice for Specifying Color by Using the Optical Society of America Uniform Color Scales System.
 - .2 [ASTM D4797](#) 882004 Standard Test Methods for Chemical and Gravimetric Analysis of White and Yellow Thermoplastic Traffic Marking Containing Lead Chromate and Titanium Dioxide.
- .2 Environment Canada (EC)
 - .1 Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations, SOR/2009-264.
- .3 Green Seal (GS)
 - .1 GS-11-Edition 3.2 (2015), Standard for Paints and Coatings.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Safety Data Sheets (SDS).
- .5 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
 - .1 MPI #32, Traffic Markings Paint, Alkyd.
 - .2 MPI #97, Latex Traffic Marking Paint.
- .6 South Coast Air Quality Management District (SCAQMD)
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets for pavement markings and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit to Consultant following material sample quantities at least 4 weeks prior to commencing work.
 - .1 Two 1 L samples of each type of paint.
 - .2 Sampling to MPI Painting Manual.
 - .2 Mark samples with name of project and its location, paint manufacturer's name and address, name of paint, MPI specification number and formulation number and batch number.

1.3 CLOSEOUT SUBMITTALS

- .1 Operations and Maintenance Data: submit information on materials relative to work of this Section for inclusion in operations and maintenance manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect specified materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.5 SITE CONDITIONS

- .1 Sustainable Design Provisions:
 - .1 Seasonal restriction for high VOC content traffic marking coatings.
 - .1 Traffic marking coating application between May 1st and October 15th subject to seasonal use restriction and have VOC concentration maximum 150 g/L.

Part 2 Products

2.1 MATERIALS

- .1 Alkyd Traffic Paint and Markings:
 - .1 To MPI #32, Alkyd traffic marking meeting requirements of [ASTM D4797](#)
 - .2 Traffic Marking Coatings: maximum VOC limit 450 g/L to SOR/2009-264 Schedule 1 and to GS-11
 - .3 Colour: to [ASTM E1360](#), yellow in accordance with MPI Architectural Painting Specification Manual
 - .4 Upon request, Consultant will supply qualified product list of paints applicable to work. Qualified paints may be used but Consultant reserves right to perform further tests.
- .2 Thinner: to MPI listed manufacturer

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates and surfaces to receive pavement markings acceptable for product installation in accordance with MPI instructions prior to pavement markings application
 - .1 Visually inspect substrate in presence of Consultant.
- .2 Pavement surface: dry, free from water, frost, ice, dust, oil, grease and other deleterious materials.
- .3 Proceed with Work only after unacceptable conditions rectified.

3.2 EQUIPMENT REQUIREMENTS

- .1 Paint applicator: approved pressure type mobile with positive shut-off distributor capable of applying paint in single, double and dashed lines and capable of applying marking components uniformly, at rates specified, and to dimensions as indicated.

3.3 APPLICATION

- .1 Pavement markings: laid out by Contractor.
- .2 Unless otherwise approved by Consultant, apply paint when air temperature minimum 10 degrees C, wind speed maximum 60 km/h and no rain forecast within next 4 hours.
- .3 Apply traffic paint evenly at rate of 3 m²/L to form minimum 8 mil dry film thickness, in accordance with MPI Architectural Painting Specification Manual "Preparation of Surfaces" and "Application" for "Approved Product" listing
- .4 Do not thin paint unless approved by Consultant.
- .5 Symbols and letters to dimensions indicated.
- .6 Paint lines of uniform colour and density with sharp edges.
- .7 Thoroughly clean distributor tank before refilling with paint of different colour.

3.4 TOLERANCE

- .1 Paint markings: within plus or minus 12 mm of dimensions indicated.
- .2 Remove incorrect markings in accordance with Manufacturer's recommendations.

3.5 CLEANING

- .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
 - .1 Remove insulation material spilled during installation and leave work area ready for application of wall board.

3.6 PROTECTION

- .1 Protect pavement markings until dry.
- .2 Repair damage to adjacent materials caused by pavement marking application.

END OF SECTION

1 GENERAL

1.1 General Requirements

- .1 Refer to Division 1, General Requirements.
- .2 This section of the specification forms an integral part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Description

- .1 Supply all products, labour, equipment, and services necessary to install exterior site furniture as indicated in the contract documents.

1.3 Requirements Included

- .1 Furnish all labour, materials, equipment, and services necessary to supply and install tree grates, benches, bike racks and trash receptacles.

1.4 Guarantee

- .1 The Contractor hereby warrants that the Site Furnishings and their installation will remain free of defects and in good condition in accordance with the General Conditions.

2 PRODUCTS

2.1 Bike Racks: See Landscape Drawings for Bike Rack.

- .1 Finish: To manufacturer's specifications.

2.2 Benches: See Landscape Drawings for Benches.

- .1 Finish: To manufacturer's specifications.

2.3 Trash Receptacle: See Landscape Drawings for Trash Receptacles.

- .1 Finish: Black – To manufacturer's specifications.

2.4 Picnic Tables: See Landscape Drawings for Picnic Tables.

- .1 Finish: Black - To manufacturer's specifications.

2.4 Non-structural steel landscape walls: See Landscape Drawings for walls.

- .1 Finish: Powder Coated Steel. Colour TBD.
- .2 Shop drawings to be provided for approval prior to ordering.

3 EXECUTION

3.1 Installation

- .1 Bike Racks:
 - .1 Assemble and install bench in accordance with manufacturer's instructions.
-

- .2 Bolt to concrete footing, and, or paving, as per manufacturer's specifications with 20 mm (3/4") Galv. bolts.
- .3 Use galvanized fittings.
- .4 Touch-up damaged finishes to the acceptance of Owner's Representative.
- .2 Bench:
 - .1 Assemble and install bench in accordance with manufacturer's instructions.
 - .2 Bolt to concrete footing, and, or paving, as per manufacturer's specifications with 20 mm (3/4") Galv. bolts.
 - .3 Touch-up damaged finishes to the acceptance of Owner's Representative.
- .3 Trash Receptacle:
 - .1 Assemble and install trash receptacle in accordance with manufacturer's instructions.
 - .2 Bolt to concrete footing, and, or paving, as per manufacturer's specifications with 20 mm (3/4") Galv. bolts.
 - .3 Touch-up damaged finishes to the acceptance of Owner's Representative.
- .4 Picnic Tables:
 - .1 Assemble Tables in accordance with manufacturer's instructions.
 - .2 Touch-up damaged finishes to the acceptance of Owner's Representative.
- .4 Non-Structural Landscape Walls:
 - .1 Assemble and install walls per approved shop drawings.
 - .2 Touch-up damaged finishes to the acceptance of Owner's Representative.

END OF SECTION 32 37 00

1 GENERAL

1.1 General Requirements

- .1 Refer to Division 1, General Requirements.
- .2 This section of the specification forms an integral part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Description

- .1 Supply all products, labour, equipment, and services necessary to prepare the site suitable for subsequent work indicated in the contract documents, including but not limited to:
 - .1 Preservation and protection of existing site features.
 - .2 Draining of wet areas of the site by means of temporary ditches, pumping and other means approved by the Owner's Representative.
 - .4 Stripping and disposal of all existing materials to prepare for path and base as detailed. All other deleterious materials, including unsuitable material under areas to be filled, shall be treated as over excavation.
 - .5 Stripping and removal of all deleterious materials.
 - .6 Stripping and stockpiling topsoil (if any).
 - .7 Grading of the site, including the importation of and relocation of fill to create compacted subgrades as required for subsequent work as detailed and specified.
 - .8 Work from existing conditions and grades shown on plans. The intent is to balance structural cut and fill on site. Grades shown on drawings may be revised in conjunction with the Owner's Representative to achieve this balance.
 - .9 Placing approved fill, subbase, base, and associated materials as detailed.
 - .10 Finished grading of the site for landscaping including unit concrete pavers, concrete paving, asphalt paving, irrigation, sodding, seeding, and planting.

1.3 Related Work

- .1 Growing Medium – Section 32 91 13
- .2 Sodding – Section 32 92 23
- .3 Planting of Trees, Shrubs and Groundcovers – Section 32 92 00

1.4 Quality Assurance

- .1 Codes and Standards: Perform backfilling work in compliance with applicable requirements of governing authorities having jurisdiction.
-

- .2 Inspection: The Owner's Representative or his representative is to inspect and approve all stages of the work. The Contractor shall give forty-eight (48) hours notice to the Owner's Representative when inspection is required.

1.5 Job Conditions

- .1 Use all means necessary to control dust, dirt and debris on and near the worksite, including Construction Access Route (C.A.R.), caused by the Contractor's operations. Thoroughly moisten all surfaces, when necessary, to prevent dust being a nuisance in adjoining areas.
- .2 Use all means to protect all materials of this Section before, during and after installation. Protect all trees designated to remain. Make good any damage. Protect existing fencing, walls, curbs, sidewalks, pavement, benchmarks, surface, or underground utilities that are to remain. Notify the Owner's Representative immediately if any damage occurs. Restore to original or better condition, unless directed otherwise.
- .3 Protect adjacent construction and all surrounding properties, including municipal streets, sidewalks, above and underground services.
- .4 Obtain approval from Owner's Representative on designated Construction Access Route (C.A.R.) Ensure C.A.R. is appropriately signed and maintained during course of construction. Remediate to original condition prior to Substantial Performance.
- .5 Maintain any existing fence barriers currently on-site surrounding areas of preserved existing vegetation. Do not enter areas of preserved existing vegetation without the approval of the Owner's Representative.

1.6 Site Conditions

- .1 Start of work shall signify acceptance of site as satisfactory and no claim will be recognized for extra work, nor any allowance made for defective work due to site conditions.
 - .2 Investigate the site to verify information shown in Contract Documents. **Verify that existing grades are as shown on Drawings and notify Owner's Representative immediately of any discrepancies.**
 - .3 Review existing site conditions with regard to subsurface conditions. Data on indicated subsurface conditions is not intended as representations or warrants of continuity of such conditions. Additional test borings and other exploratory operations may be made by Contractors at no cost to the Owner. Notify Owner's Representative prior to carrying out any such work.
-

1.7 Testing and Approvals

- .1 The Contractor is to provide testing of the subgrade preparation for all paving areas, to ensure the requirements of the Contract and General Conditions are being met. The Contractor at no extra cost to the contract shall provide any retesting due to non-conformance.

1.8 Materials Definitions

- .1 The terms "subgrade", "subbase", and "base", wherever used in the contract documents shall mean materials that meet the requirements stated herein for each class of material.

1.9 Submittals

- .1 If required, provide representative samples for subbase, base, drain rock (clear crush), quarry tailings, riprap or any another aggregate material used on site, at least fourteen (14) days before scheduled time of delivery to site.

2 PRODUCTS

2.1 Subgrade

- .1 Subgrade is a dense surface that has been proof rolled as specified and which has been treated to eliminate all soft or spongy areas. Compaction and uniformity of subgrade shall be subject to approval by the Owner's Representative.
- .2 Subgrade may be existing, undisturbed material resulting from cutting or may be built up using Type 1 fill or Type 2 fill, depending on the applications.

2.2 Fill

- .1 Fill material shall be natural mineral material of a consistent quality throughout, free from foreign matter such as construction debris, plant and grass seeds, organic matter (except within limits shown for Type 1) and pests, and meeting the requirements set out for Type 1 or Type 2 fill, depending on the application.
 - .2 Obtain the Owner's Representative's approval of fill material before delivering to the site if imported, or before moving on site if native. **If imported material is approved for use, supply Owner's Representative with written notification a minimum of thirty (30) days prior to beginning fill operations a complete statement of origin, compensation, suitability, environmental clearance, and proposed location of all deposits that is intended for imported fill.**
 - .3 Fill shall be classed as Type 1 or Type 2, depending on its application and shall meet the following requirements for each type:
-

TYPE	APPLICATION	REQUIREMENTS
Type 1	Under planted and grass areas	Maximum aggregate size 200mm evenly graded, containing not more than 20% fines (clay and silt) and not more than 5% organic matter, or as approved by the Owner's Representative.
Type 2	Under subbase for pathways, paved areas, structures	Maximum aggregate size 200mm evenly graded, containing not more than 15% fines passing a No. 200 (0.075mm) sieve when tested according to ASTM designation C-136. The Owner's Representative may approve alternatives.

2.3 Subbase

- .1 Subbase shall be crushed granular aggregate composed of inert, clean, tough, durable particles capable of withstanding the effects of handling, spreading and compaction without excessive degradation or production of deleterious fines. The aggregate shall be reasonably uniform in quality and free from an excess of flat or elongated pieces.
- .2 All subbase aggregate shall have a gradation within the limits set out herein when tested according to ASTM designation C-136.

Sieve Size (mm)	Total Percent Passing
75.0	100
37.5	60 - 100
20.0	40 - 80
9.5	30 - 60
4.75	20 - 45
2.36	15 - 35
1.18	10 - 25
0.300	4 - 16
0.075	2 - 9

2.4 Drain Rock, Clear Crush

- .1 5mm to 19mm uniform clear crush.

2.5 Filter Fabric

- .1 Needle-punched, non-woven filter fabric, Nillex 4551 as manufactured by Nillex, or pre-approved equivalent.

2.6 Base

- .1 20mm diameter minus domestic or imported material below all paved surfaces. Material shall be free of organic and other deleterious material with the following particle size breakdown:

Sieve Size (mm)	Total Percent Passing
20.0	100
9.5	60 - 95
4.75	40 - 70
2.36	30 - 60
1.18	20 - 45
0.300	8 - 45
0.075	2 - 9

2.7 Construction Fencing

- .1 Metal fencing is required around the entire construction site. Fencing to be a minimum of 1.8m in height. Fencing to be "Modu-Loc" or equivalent, and is to be approved by Owner's Representative before installation. The Contractor is to ensure fencing is secure at all times, so as to prevent intrusion into the construction site by any unauthorized persons. Panels to be pinned to the ground and bolted together. Contractor is responsible for maintaining the integrity of the fencing in a vertical position at all times. Fencing is to be reviewed by the Owner's Representative before the start of any construction activities and is to remain in place until Final Acceptance.

3 EXECUTION

3.1 Limits of Work

- .1 Before starting work identify the limits of work on site by accurate survey. Prior to grading, excavating or trenching the Contractor shall locate and expose all utility lines, drain pipes and all other services which are within the areas of this work, and where the existing services are located less than 300mm below the proposed depth of trenching or excavation, such existing services shall be exposed by hand and adequately marked and protected. All separation distance requirements of the local authorities having jurisdiction over the service shall be observed.
- .2 Take all measures necessary to prevent the following activities outside the limits of work except as authorized by the Owner's Representative:
- .1 Travel of equipment and vehicles
 - .2 Storage of materials or equipment
 - .3 Stockpiling of soil or excavated materials
-

- .4 Burning
- .5 Excavating or trenching
- .6 Cutting of roots or branches
- .7 Disposal or spilling of toxic matter

3.2 Unsuitable Material

- .1 Remove from the site all material unsuitable for use as fill.

3.3 Drainage

- .1 Drain and/or dewater all areas to be regraded using methods acceptable to the Owner's Representative and local environmental authorities having jurisdiction.
- .2 Slope rough grades away from any building envelopes/ structures at a minimum 2%, unless specifically shown on drawings or directed by Owner's Representative.

3.4 Excavation and Filling

- .1 Cut, fill and import material as required to create subgrades as detailed and specified herein.
 - .2 Remove all deleterious material and ponded water from the site.
 - .3 Compact exposed ground surface beneath all fill areas with a minimum 5 ton vibrator roller, except in "soft" landscape areas, i.e. areas to receive grass or planting.
 - .4 Any soft or spongy areas shall be sub-excavated, removed and replaced with granular subbase material. Such fill shall be placed in maximum 200mm lifts and compacted to the densities required for Type 1 or Type 2 fill.
 - .5 Scarify existing grades to a minimum depth of 150mm prior to placing of fill. Move excavated material intended for reuse as fill directly from the cut to the fill area, spread and compact to the required densities.
 - .6 Place fill in maximum 200mm lifts and compact each lift to the following Standard Proctor Densities, to ASTM D698 using approved vibratory compaction equipment, prior to placing subsequent layers as follows:
 - Type 1 Fill: 95% Standard Proctor Density (S.P.D.).
 - Type 2 Fill: 98% Standard Proctor Density (S.P.D.).
 - .7 Compact fill materials only when the moisture content is suitable for obtaining the specified density. If moisture content is too low, apply water by means of approved distribution. If moisture content is too high, dry the fill material by blading, disking, or other approved method. **DO NOT OVER COMPACT FILL TYPE 1.**
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- .8 Excavated material used as Fill Type 2, shall be overlaid with a minimum of 200mm of subbase, compacted to 98% Standard Proctor Density.

3.6 Grading

- .1 **DO NOT GRADE SOIL WHEN SOIL IS WET.** Uniformly grade areas within limits of grading under this Section. Smooth finished surface within specified tolerances, compact with levels or slopes between elevations as shown, or between such points and existing grades.
- .2 Grade areas to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and to allow for specified depths of base courses and finished materials.
- .3 Remove particles larger than 100mm diameter from the surface leaving a smooth compacted surface to required subgrade.
- .4 Compact subgrade as required, to stated densities in the above section.

3.7 Subbase and Base

- .1 Ensure base materials and existing surface are at approximately the same moisture content to facilitate bonding.
- .2 Install subbase, base, and filter fabric as detailed. Place in maximum 200mm lifts and compact to minimum 98% Standard Proctor Density (S.P.D.).
- .3 Finish to subgrades as detailed, suitable for subsequent installation of path and base, structures and paving.

3.8 Tolerances

- .1 Maximum subgrade tolerance is ± 25 mm when checked with a 3 m straight edge placed in any direction, and the subgrade shall not be consistently above or below the design grades.

3.9 Maintenance

- .1 Protect newly graded areas from traffic, erosion, and standing water and free of debris. Provide temporary drainage ditches from graded areas as required.
-

- .2 The site surface shall always be contoured to direct precipitation and run-off to drainage ditches or slopes leading away from the work area. Surfaces shall always be left graded smooth and rolled with a smooth drum roller to minimize infiltration of water and subsequent deterioration of material due to excessive moisture content. The surface shall never be left with undrained depressions or with a rough texture.
- .3 Repair and re-establish grades in settled, eroded and rutted areas to specified tolerances.
- .4 Repair and make good and clean up any damage and/or debris to municipal roads and streets caused by work of this Contract. Obtain and pay for all permits required for use of municipal roads and streets.

3.10 Cleaning

- .1 Remove excess excavated material, trash, debris and waste materials and dispose of off site as directed by Owner's Representative at no additional cost to the Owner.

END OF SECTION 32 91 00

1 GENERAL

1.1 General Requirements

- .1 Refer to Division 1, General Requirements.
- .2 This section of the specification forms an integral part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Description

- .1 Supply all products, labour, equipment, and services necessary to install growing medium and mulch as indicated in the contract documents. Growing medium for landscape areas and planters.

1.3 Related Work

- .1 Sodding Section – 32 92 23
- .2 Planting of Trees, Shrubs, and Groundcovers – Section 32 92 00

1.4 Reference Standards

- .1 Conform to the requirements of the latest editions of the following standards and legislation:
 - .1 CLS / Canadian Landscape Standard
 - .2 Canadian System of Soil Classification
 - .3 Canadian National Master Construction Specification, 32 91 19.13 Topsoil and Grading.

1.5 Materials Definitions

- .1 For the purpose of this specification the term “growing medium” shall mean a mixture of mineral particulates, microorganisms and organic matter which provides a suitable medium capable of supporting the intended plant growth.

1.6 Types and Locations of Growing Medium

- .1 Provide and install the following types of growing medium at the locations shown for each type:
- .2 Growing medium types:
 - .1 TYPE A On Site/Imported Soil
 - .2 TYPE B Growing Medium

1.7 Review

- .1 Verify the size, location and depth of all existing site services and sub-surface utilities prior to commencement of the work. Repair all damage as result of failure to perform adequate review at no cost to the Owner's Representative.
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- .2 Notify Owner's Representative when the site is prepared for growing medium placement. Do not place growing medium until subgrades have been reviewed and approved.
- .3 Provide at least two days (48 hours) notice in advance of each required reviewed.

1.8 Testing

- .1 Submit to the Owner's Representative a copy of growing medium analysis from a laboratory approved by the Owner's Representative. The analysis shall be of tests done on the proposed growing medium from samples taken at the supply source within three weeks immediately prior to soil placement. Cost of initial analysis and subsequent tests to ensure compliance with specification shall be borne by the contractor. **Results of these tests shall be presented to the Owner's Representative for review BEFORE any growing medium delivery to site.**
- .2 The analysis will include measurement of percent sand, fines, (silt and clay), and organic matter to total 100%, pH, lime required to achieve pH 6.5, water soluble salts, total carbon to total nitrogen ratio, total nitrogen and available levels of phosphorus, potassium, calcium and magnesium
- .3 The analysis shall outline the testing laboratory's recommendations for amendments, fertilizer and other required modifications to make the proposed growing medium meet the requirements of this specification.
- .4 At the discretion of the Owner's Representative submit up to two additional samples at intervals outlined by the Owner's Representative of growing medium taken from material delivered to site. Samples shall be taken from a minimum of three random locations and mixed to create a single uniform sample for testing. Results of these tests shall be presented to the Owner's Representative for review.
- .6 Failure to satisfy these contractual requirements could result in the contractor being required to remove unacceptable growing medium at their expense.

1.9 Submittals

- .1 Submit to the Owner's Representative a copy of an analysis by an approved independent soil-testing laboratory. The analysis shall be of tests done on the proposed growing medium and additives proposed for the work from samples taken at the supply source, within three weeks immediately prior to growing medium placement. Costs of the initial analysis, and subsequent tests to ensure compliance with the specification shall be borne by the Contractor. Failure to submit soils analysis is cause for immediate rejection and possible removal of any placed growing medium.
-

- .2 The analysis shall include a breakdown of the following components: total nitrogen by weight, available levels of phosphorous, potassium, calcium, magnesium, soluble salt content, organic matter by weight, % sand, % fines (silt and clay) and pH value. In addition, the analysis shall clearly indicate the Project Name, Date Tested and Contractor's Name.
- .3 Submit with the above analysis, the testing laboratory's recommendations for amendments, fertilizers, and other modifications to make the proposed growing medium meet the requirements of this specification.

1.10 Samples

- .1 Submit to the Owner's Representative one composite sample of each type of proposed growing medium for each different application within the project (e.g. lawns, shrubs, trees). Each sample shall be a composite of at least three samples from the proposed source and shall be at least one (1) litre in volume.

1.11 Quality Assurance

- .1 Advise Owner's Representative of sources of growing medium to be utilized on this Project a minimum of thirty days (30) prior to starting work of this Section.
- .2 Carry out growing medium preparation and placement such that the final product matches the standard set by the samples submitted, within a range of variation that may reasonably be expected with good quality control while incorporating the recommendations for amendment by the testing laboratory.
- .3 The Owner's Representative may appoint an independent testing laboratory to ascertain compliance with this specification and to recommend modifications to make the growing medium meet the requirements of this specification.

2 PRODUCTS

2.1 General

- .1 Product Handling
 - .1 Do not move or work growing medium or additives when they are excessively wet, extremely dry, frozen, mixed with ice and/or snow, or in any manner which will adversely affect growing medium structure. Growing medium whose structure has been destroyed by handling under these conditions will be rejected and shall be replaced by the contractor at no cost to the owner.
 - .2 Protect growing medium and additives against extreme wetting by rain or other agents, and against contamination by weeds and insects.
 - .3 Deliver fertilizer and other chemicals in manufacturer's original containers. Protect against damage and moisture until incorporated into the work.
-

- .4 Stockpile materials in bulk form in paved areas and provide protection by storing under roof or tarpaulins. Take all necessary precautions to prevent contamination of component materials from wind blown soils, weed seeds and insects. Contamination of individual components may result in rejection, if used.
 - .5 All growing medium will be delivered to site **premixed** from a recognized growing medium source ensuring consistency throughout the mix.
- 2 Approved Equals
- .1 All items as specified or pre-approved equals.

2.2 On Site /Imported Soil (Type A)

- .1 On site-imported soil shall be friable "A Horizon" topsoil to the requirements of the Canadian Landscape Standard, stripped and stockpiled on site in an approved location. Stripping and stockpiling work shall be such that the soil is not damaged or contaminated. (Refer to Product Handling).
- .2 Mineral particle sizes shall be within the following ranges by weight:
100% shall pass a 10 mm (3/8") sieve.
Maximum of 10% shall pass a #200 sieve. (Silt and clay)

Soil shall be of a sandy loam or loamy sand texture containing between 3% and 15% organic matter (dry weight basis). Soil shall be virtually free from subsoil, wood including woody plant parts, weeds, stones over 30mm, pests, undesirable grasses or weeds, and seeds or parts thereof and foreign objects. Soil shall be free from crabgrass, couch grass, *Equisetum*, convolvulus or other weeds or seeds or parts thereof.
- .3 Soil shall be suitable for modification by screening and additives to meet the requirements for Screened Growing Medium (Type B as specified) except where specified and approved for use as unscreened On Site Soil (Type A).

2.3 Additives

- .1 Manure: Well rotted farm animal manure or compost, to the requirements of the Canadian Landscape Standard. Animal manures and compost often have excessive levels of water-soluble salts. The growing medium shall be leached via fresh water from the irrigation system or through natural rainfall until an electrical conductivity of 3.0mmho/cm or less is achieved.
-

- .2 Compost: A uniform blend of natural source-separated organic materials, composted such that it is brown-black in colour and has carbon to nitrogen ratio of 25 to 1 or lower. pH 6 to 7. Substantially free from subsoil, pests, roots, wood, construction debris, undesirable grasses or weeds, and seeds or parts thereof. Free from toxic materials, crabgrass, couch grass, equisetum, weeds, and seeds or parts thereof. The Owner does not allow use of any paper fibre amended compost products.
- .3 Sand: Approved medium river pump sand, well washed and free of contaminants, chemical and organic matter. Gradation of particle sizes shall fall within the following range ("Percent" to be reported as the mass of the particles whose size is less than the designated sieve opening but greater than the next designated sieve opening):

USBS Sieve Sieve Size

<u>Number</u>	<u>(mm)</u>	<u>Percent Class</u>
4	4.76	0 - 3 Fine gravel
10	2.00	0 - 20 Very coarse sand
18	1.00	0 - 20 Coarse sand
35	0.50	60 - 80 Medium sand
60	0.25	0 - 40 Fine sand
140	0.105	0 - 4 Very fine sand
270	0.063	0 - 2 Silt & clay

- .4 Sand shall have a saturated hydraulic conductivity between 100 mm. and 300 mm. per hour. Test conditions shall be for saturated sand, 15 blows compaction.
- .5 Sand shall have:
- | | |
|----------------------------|-------------------|
| Organic content | < 0.5% by weight. |
| Water Soluble Salt content | < 0.5mmhos/cm |
| Ph of between | 5.0 and 7.0 |
- .6 Available copper, zinc and manganese following acid digest test in 0.1N HC1 and shaken for ½ hour shall be less than 25 PPM when analysed by atomic absorption spectroscopy.
- .7 Peat moss: Is not to be used.
- .8 Wood Residuals: Content of wood residuals such as fir or hemlock sawdust shall not cause a Carbon to Nitrogen ratio higher than 25:1. Cedar or redwood sawdust shall not be present in the growing medium mix.
- .9 Dolomite Lime: Approved commercial brands for horticultural purposes, coarsely ground; containing not less than 20% calcium by weight.
-

2.4 Fertilizers

- .1 Standard commercial brands, meeting the requirements of the Canada Fertilizer Act, packed in waterproof containers, clearly marked with the name of the manufacturer, weight and analysis.
- .2 Generally Fertilizers must be those amendments specified in the soils analysis report/ recommendations. Contractor shall not make any substitutions without prior written approval from Owner's Representative.

2.5 Growing Medium (Type B)

- .1 Growing Medium shall be predominantly sand based and screened with additives and fertilizers as required to make it meet the following specifications:
 - .1 Substantially free from roots, sticks, building materials, wood chips, chemical pollutants and other extraneous materials.
 - .2 Population of plant pathogenic nematodes: maximum 1000 per litre for any single species.
 - .3 Maximum requirement of dolomite lime to required pH: 50kg/100M2.
 - .4 Salinity: maximum saturation extract conductivity of 3.0 mmho/cm @25 deg. C
 - .5 Fertility:

Total Nitrogen	0.4-0.8% by weight
Available Phosphorous	70-80 ppm
Available Potassium	150-250ppm
 - .6 Cation Exchange Capacity: 30-50 meq.
 - .7 Carbon to Nitrogen Ratio: max. 40:1
 - .8 pH:

Lawns	6.0 to 7.0
Planting Areas	5.5 to 6.0
 - .9 Boron: the concentration in the saturation extract shall not exceed 1.0 ppm
 - .10 Sodium: the sodium absorption ratio (SAR) as calculated from analysis of the saturation extract shall not exceed 8.0
 - .11 Total Nitrogen shall be 0.2% to 0.6% by weight.
 - .12 Available phosphorous shall be 20-100 ppm
 - .13 Available potassium shall be 50-250 ppm.
 - .14 Tolerances: Samples of growing medium taken just before planting shall have the specified properties to within the tolerances of plus or minus 20% of the stated values, except for salinity, which shall be less than the stated limit.
 - .15 The textural properties and organic content shall have the following composition AFTER MIXING (BY DRY WEIGHT):
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- .2 For PLANTING BEDS growing medium shall consist of the following AFTER MIXING (% BY DRY WEIGHT):

80- 88% round sand (>0.05mm-<2mm)
3 % max silt (>0.0002mm - <0.05mm)
2 % max clay (<0.002mm)
Total fines max 5%
12-15% organic matter
pH 5 .0 to 6.0

Nutrient Content:

Nitrogen 0.2 - 0.6%
Phosphorus: 50 -150ppm
Potassium 50 - 300 ppm
C/N ratio max 25 : 1

- .3 For LAWN AREAS growing medium shall consist of the following AFTER MIXING (% BY DRY WEIGHT):

85- 92% round sand (>0.05mm-<2mm)
3 % max silt (>0.0002mm - <0.05mm)
2 % max clay (<0.002mm)
Total fines max 5%
8- 10% organic matter
pH 6 .0 to 6.5

Nutrient Content:

Nitrogen 0.2 - 0.6%
Phosphorus: 50 -150ppm
Potassium 50 - 300 ppm
C/N ratio max 25 : 1

2.6 Organic Material

- .1 Organic Material (non urban agriculture):
- .1 Shall be, fully composted material that does not contain cedar or redwood bark or wood, black/brown in colour.
 - .2 Organic component shall not contain mushroom manure compost or mushroom starter.

2.8 Drainage Medium

- .1 Drain Rock or Gravel: Shall consist of clean round stone or crushed rock. Acceptable material includes 19 mm (3/4") drain rock or torpedo gravel conforming to the following gradations.
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SIEVE SIZE	PERCENT PASSING (19MM)	PERCENT PASSING (TORPEDO)
25mm	100	
19mm	0-100	
9.5mm	0-5	100
4.75mm	0	50-100
2.36mm		10-35
1.18mm		5-15
0.60mm		0-8
0.30mm		0-5
0.15mm		0-2

.2 Drain Mat: Light duty, UV stable, impermeable cuspated core bonded to a layer of non-woven filter fabric with the following minimum properties:

- .1 Compressive Strength -718 kN/m² as per ASTM D-1621
- .2 Flow Rate – 188 l/min/Metre as per ASTM D-4716
- .3 Approximate profile thickness of 10mm (3/8").
 Acceptable products include J-DRain 200 manufactured by JDR Enterprises (1.800.843.7569), Nudrain WD/15 manufactured by Nilex Geotechnical Products Inc., Burnaby B.C., or approved equal.

2.9 Filter Fabric

.1 Needled, non-woven polypropylene mat. Nilex 4545 by Nilex Geotechnical Projects, Burnaby, B.C.

3 EXECUTION

3.1 Subgrade Preparation

- .1 All excavation shall be undertaken in accordance with the local standards.
- .2 Request a review of the subgrade conditions and obtain approval of the Owner's Representative to placing any growing medium.
- .3 On Grade Planting Area:
 - .1 Scarify compacted subgrade to a minimum depth of 200mm (8") immediately before placing growing medium.
 - .2 Verify that subgrades are at the proper elevations before placing growing medium.
 - .4 Placement of growing medium implies acceptance of subgrade conditions.
 - .5 Remove debris, roots, branches stones in excess of 50mm dia. and other deleterious materials as directed by Owner's Representative.

- .6 Remove any soil contaminated with calcium chloride, toxic materials, or petroleum products.
- .7 Remove any materials that protrude 25mm above the surface.
- .8 Dispose of removed material off site.
- .9 Review sub grade conditions to ensure that there is proper drainage in all planting areas and tree pits. Perform a percolation test as needed to confirm proper drainage.
- .4 Planting adjacent building walls:
 - .1 Verify planter drains and or slab drains have been installed.

3.2 Placement of Drainage Medium – Drain Rock

- .1 Verify that architectural slab membrane, protection board, insulation, etc. has been approved by the Owner's Representative prior to the placement of drainage medium.
- .2 Place drainage medium over entire planter bottom ensuring consistent depth as per construction details.
- .3 Place filter fabric over the entire finished surface of drainage medium. Ensure seams are overlapped as per manufacturers recommendations.
- .4 Ensure filter fabric fits tight to face of planter wall. Take care during loading of growing medium to ensure filter fabric is not dislodged.

3.3 Placement of Drainage Medium – Drain Mat

- .1 Verify that architectural slab membrane, protection board, insulation, etc. has been approved by the Owner's Representative prior to the placement of drainage medium.
- .2 Place drainage medium – drain mat over entire planter bottom cut outs for slab drains. Ensure that overlap of filter cloth portion of drain mat is provided as per manufacturers recommendations. Ensure there are no gaps between drainage medium panels.

3.4 Importing Procedures for Prepared Growing Medium

- .1 **Imported Growing Medium:** Growing medium shall be imported and stockpiled on site in a location approved by the Owner's Representative.
 - .1 Carry out stock piling operation such that the growing medium structure is not compromised through compaction, vibration, or other actions.
 - .2 Stockpiled growing medium shall be protected from rain, drying and contaminants.
 - .3 Growing medium shall be free of subsoil, pests, roots, wood, construction debris, undesirable grasses including crabgrass or couch grass, noxious or weeds and weed seeds or parts thereof foreign objects and toxic materials. Presence of these contaminants shall be grounds for rejection of growing medium and replacement at no cost to the Owner.
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3.6 Preparation of Growing Medium

- .1 Mixing/screening of growing medium on site is not allowed. All growing medium is to arrive pre-mixed with the exception of addition of the following components that are to be applied at rates indicated in the growing medium analysis recommendations:
- .2 Thoroughly mix using mechanical mixing/screening equipment the constituent growing medium components and recommended additives. Resulting mixture will have a particle size class and properties that match the requirements of this specification.
- .3 No hand mixing will be accepted unless specifically approved by the Owner's Representative.

3.7 Placing Growing Medium

- .1 Do not place growing medium until Owner's Representative has reviewed drainage medium installation.
 - .2 Growing medium shall be moist but not wet when placed (25% of field capacity). It shall not be handled in anyway if it is wet or frozen.
 - .3 Place all growing medium to the required finished grades with adequate moisture in uniform lifts of 100mm to 150mm compacted to 80MPD during dry weather, over drainage medium where planting is indicated.
 - .4 Except where drawings or details show otherwise, place to the following minimum and/or maximum depths and levels (measured after initial settling of growing medium):
 - .1 Tree Planting Areas on grade maximum 900mm (36") and shall conform to the following additional parameters:
 - .1 Planting hole shall be minimum 300mm (12") wider than rootball on all sides.
 - .2 Planting hole shall be minimum depth of root ball. Undisturbed soil below rootball to be compacted to 100MPD.
 - .3 Each tree shall have access to minimum 30m³ growing medium volume and minimum 15m³ growing medium volume per tree within connected volumes.
 - .4 The required growing medium volume may be accommodated with varying soil depths between 900mm (36") and 250mm (10") outside the area defined by the planting hole. The growing medium volume must have a direct relationship to the mature drip line with outward adjustment for columnar species.
 - .2 Shrub and Groundcover Areas on grade 450mm (18") minimum depth.
 - .3 Low or High Traffic Lawn Areas on grade 250mm (10") minimum depth.
 - .5 If subgrade/subsoil drains rapidly increase soil depths as directed by Engineer to ensure adequate moisture retention.
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- .6 For Lawn Areas Flush with adjacent surfaces after initial settlement.
- .7 Crown or slope for positive surface drainage as shown on the drawings.

3.8 On Site Application of Amendments

- .1 Ensure minimum 7 days separation time between the application of any lime treatment or fertilizers and plant material installation.
- .2 Addition of amendment components shall be at the rates indicated in the growing medium analysis recommendations via the following methods:
 - .3 Fertilizers
 - .1 This material shall be applied with mechanical spreaders over the entire planting area
 - .2 Rake fertilizers into top 50mm minimum of the placed growing medium.
 - .4 Lime
 - .1 This material shall be applied with mechanical spreaders over the entire planting area and mixed thoroughly into the top 100mm (4") of the growing medium prior to fine grading.
 - .2 Do not apply by hand.
 - .2 Ensure lime does not come in contact with the nitrogen - phosphate - potash fertilizers during amending process.
 - .5 Organic Matter
 - .1 Organic matter shall be top-dressed and cultivated into the top 150 -200mm (6"-8") of the growing medium prior to fine grading.

3.9 Finish Grading

- .1 Manually fine grade growing medium installation to contours and elevations shown on drawings or as directed by Owner's Representative. Tolerance for finish grading to be 5mm.
- .2 Eliminate rough spots and low areas to ensure positive drainage.
- .3 Finish Grade of growing medium shall be 25 mm (1") from finished elevation of adjacent curb or planter wall unless otherwise noted on drawings
- .4 Leave surface smooth, uniform, firm against deep foot printing, with a fine loose texture.

3.10 Weed Control

- .1 Ensure all weeds and weed roots that have germinated during the course of work of this section have been eliminated from growing medium.
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- .2 Provide the Owner's Representative with a written methodology outlining of weed removal seven (7) days prior to starting weed removal operations.

3.11 Mulching

- .1 Place mulch over all growing medium except grass areas. Moisten uniformly and spread to a consistent settled depth of 50mm in tree and shrub planting areas, 25mm in ground cover areas.

3.12 Acceptance

- .1 Owner's Representative will inspect and test growing medium and determine acceptance of material as placed, depth and finish grading prior to any planting or sodding operations commencing.
- .2 Approval of placed growing medium subject to additional soil test analysis if requested. Costs for additional testing of placed growing medium shall be at the Contractor's expense.

3.13 Cleaning

- .1 All excess materials and other debris resulting from growing medium preparation and placement operations shall be disposed of off site.
- .2 Ensure all discolouration of adjacent surfaces caused by growing medium placement have been removed. Ensure all paved areas, tops of planters, and adjacent surfaces have been thoroughly cleaned to the satisfaction of the Owner's Representative.

END OF SECTION 32 91 13

1 GENERAL

1.1 General Requirements

- .1 Refer to Division 1, General Requirements.
- .2 This section of the specification forms an integral part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Description

- .1 Supply all products, labour, equipment, and services necessary to install plant material as indicated in the contract documents.

1.3 Related work

- .1 Section 32 91 00 – Site Preparation and Grading
- .2 Section 39 91 13 – Growing Medium

1.4 Quality Assurance

- .1 All materials and work shall conform to the latest edition of the following standards or as otherwise specified:
 - .1 CNTA (Landscape Canada) Canadian Standards for Nursery Stock – Current Edition.
 - .2 Canadian Landscape Standard (CLS) for Container Grown plants – Current Edition.
 - .3 CLS / Canadian Landscape Standard – Current Edition.
 - .4 Perennial Plant Association Standards for herbaceous perennial plants.
 - .5 ANSI A-300 Tree Pruning Guidelines.
 - .6 Urban Tree Foundation/ISA Guideline Specifications for Nursery Tree Quality – Current Version.

1.5 Reference Standards

- .1 Trees, shrubs, and ground covers work to be done in accordance with current edition Canadian Landscape Standard (CLS) except where specified otherwise.

1.6 Source Quality Control

- .1 Seven (7) days prior to the Owner's Representative review of plant material at source the Contractor shall confirm in writing availability of plant material noted on Plant List.
 - .2 Plant material will be supplied from nurseries who are certified by the Clean Plants program, Canadian Nursery Certification Institute (CNCI), current certification standard <http://cleanplants.ca/>. The certification must extend to all fields and allied nursery operations where plant material is sourced. Only nurseries, fields and allied nursery operations that are certified will be permitted to supply plant material for this project.
 - .3 Plant Material Review at the source nursery:
 - .1 Contractor request for review of the plant material at source nursery to be a minimum of seven (7) days prior to scheduled review.
 - .2 Owner's Representative shall make one (1) visit to source nursery for review of plant material for entire project.
 - .3 If review in more than one location becomes necessary, the Contractor shall reimburse the Owner's Representative for the additional time required at the current hourly rates of the Staff personnel.
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- .4 Shipping of plant material to project site shall not proceed until Owner's Representative has reviewed the plant material at the source nursery.
- .5 All plants are subject to review and may be rejected for failure to comply with this specification at any time until Acceptance. Immediately replace rejected material and remove from the site at no cost to the Owner.
- .6 Trees required for the work must be reviewed and tagged by the Owner's Representative at the place of growth before being dug. Inspection and tagging at the place of growth shall not affect the right to reject such trees on or after delivery thereof to the site.
- .7 Plants required for the work must be reviewed by the Contractor before being prepared for delivery. Inspection shall not affect the right to reject such plants on or after delivery thereof to the site.
- .8 Plants arriving on site must be reviewed by the Owner's Representative prior to off-loading. Provide minimum 72 hours notice to schedule review.
- .9 The Contractor or his authorized representatives shall be present during all required reviews as specified or as may be required.
- .4 Plant Material Review at Project Site:
 - .1 All plant material shall be reviewed at the project site by the Owner's Representative prior to planting.
 - .2 Plant material that is rejected by the Owner's Representative shall be immediately removed from the site and replaced at the Contractors expense.
- .5 Imported Plant Material
 - .1 Plant material imported from out of province and out of country shall be accompanied with necessary federal and provincial permits and import licenses.
 - .2 The Contractor shall conform to all federal and provincial laws and regulations with regard to horticultural inspection of domestic and imported plant material.
- .6 Condition of Plant Material
 - .1 Plant rootballs and containers shall be completely free of noxious weeds and volunteer plants including, but not limited to, Horsetail and Morning Glory.
- .7 Plant material grown or supplied in Fabric Containers are not acceptable.

1.7 Scheduling

- .1 Obtain approval from Owner's Representative for schedule 7 days in advance of shipment of plant material.
- .2 Schedule to include:
 - .1 Date for selection of plant material at source by Owner's Representative.
 - .2 Quality and type of plant material.
 - .3 Shipping dates.
 - .4 Arrival dates on site.
 - .5 Planting Dates.
- .3 Schedule all operations to ensure optimum environmental protection, grading, growing medium placement, planting, seeding or sodding operations as outlined in these Specifications. Scheduling to be organized to ensure a minimum duration of on-site storage of plant material, minimum movement and compaction of growing medium and prompt mulching and watering operations. Work schedule to be coordinated with scheduling of other trades on-site.
- .4 Coordination and scheduling to be such that no damage occurs to materials before or after placement. Requirements of living plant material to be met.
- .5 Planning, scheduling, and execution of work to include measures to ensure a supply of water for landscape purposes in adequate amounts and at adequate pressures for satisfactory irrigation of all plants.

1.8 Product Data

- .1 Submit product data in accordance with Section 01 00 10 – General Requirements.

- .2 Provide product data for:
 - .1 Fertilizer.
 - .2 Anti-desiccant.
 - .3 Guying assembly including clamps, collar, guying wire, anchors, and wire tightening method.
 - .4 Mulch.

1.9 Samples

- .1 Submit samples in accordance with Section 01 00 10 – General Requirements.
 - .2 Provide samples for:
 - .1 Mulch.
 - .3 Confirmation Plant List:
 - .1 Contractor shall provide in writing to the Owner's Representative a minimum of seven (7) days prior to review of plant material at the source nursery a plant list confirming the quantity, botanical name, common name and size of plants specified.
 - .4 Prior to the review of plant material by the Owner's Representative the Contractor shall submit written documentation with CNCI certification stamp stating that the nursery has undergone all components of a certification program and has been audited to verify that all components are properly implemented. The documentation submitted shall include but is not limited to the nurseries CNCI Clean Plants certification number.
 - .5 Substitutions
 - .1 Contractor shall provide in writing to the Owner's Representative a minimum of seven (7) days prior to review of plant material at the source nursery a list of proposed substitutions for review.
 - .2 Substitutions in plant material will not be considered unless written proof is submitted thirty (30) days prior to scheduled installation stating a specified plant cannot be obtained within the specified area of search.
 - .3 Plant substitutions shall be of similar genus and species and of equal or greater size as those originally specified. The list shall contain the following information:
 - .1 Botanical name, common name of the specified plant
 - .2 Botanical name, common name of the proposed substitute plant
 - .3 Pot size, plant size and calliper of trees to be substituted
 - .4 Upon submission of such proof, a proposal will be considered for using the nearest equivalent size or variety with an equitable adjustment of the Contract price.
 - .6 Planting Schedule
 - .1 Contractor shall provide in writing to the Owner's Representative upon award of the Contract a detailed planting schedule outlining dates and duration of planting operations.
 - .2 Revisions to the Planting Schedule as a result of delays of any kind shall be submitted to the Owner's Representative in a timely manner prior to the start of planting operations.
 - .3 Composted Mulch: Contractor to submit a one (1) litre sample of Composted Mulch to the Owner's Representative for review prior to shipment to the site.
 - .4 Prepared Growing Medium: Contractor to submit a one (1) litre sample of the Prepared Growing Medium to the Owner's Representative for review prior to shipment to the site.
 - .5 Antidesiccant: Contractor to submit three (3) copies of manufacturer product data and specification for Owner's Representative review.
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1.10 Delivery, Storage, and Protection

- .1 Protect plant material from frost, excessive heat, wind and sun during delivery.
- .2 Immediately store and protect plant material which will not be installed within 4 hours after arrival at site in storage location approved by Owner's Representative.
- .3 Protect plant material from damage during transportation:
 - .1 When delivery distance is less than 30 km and vehicle travels at speeds under 80 km/hr, tie tarpaulin around plants or over vehicle box.
 - .2 When delivery distance exceeds 30 km or vehicle travels at speeds over 80 km/hr, use enclosed vehicle.
- .4 Protect stored plant material from frost, wind and sun and as follows:
 - .1 For bare root plant material, preserve moisture around roots by heeling-in or burying roots in topsoil and watering to full depth of root zone.
 - .2 For pots and containers, maintain moisture level in containers. Heel-in fibre pots.
 - .3 For balled and burlapped and wire basket root balls, place to protect branches from damage. Maintain optimum moisture level in root zones.

1.11 Acceptance

- .1 The conditions for Acceptance of landscape areas and for turning over the landscape areas to the Owner for subsequent maintenance are:
 - .1 Growing medium quality, fertility levels, depths and surface grading have been completed to the requirements of Section 32.91.13.
 - .2 Plant quantities, sizes, quality and locations are as shown in the Contract Documents or as otherwise approved by the Owner's Representative.
 - .3 Substantial Performance for the complete project shall have been declared.
 - .4 All plants shall be installed at the correct elevation relative to finished grade, healthy, in a vigorous growing condition and established to the satisfaction of the Owner's Representative.
 - .5 Trees will be assessed for acceptance only when in leaf, and not when in a dormant state.
 - .6 All deficiencies with regard to landscape work shall have been rectified.
 - .7 All trees are staked where required.
 - .8 Landscape areas shall have been maintained for at least 24 months. All planted areas are free of all visible weeds and substantially free from underground weed seeds or parts thereof, to the requirements of Section 32 01 90 Landscape Maintenance (as Applicable).
 - .9 Mulch has been placed as required. All areas not to receive mulch are in a cultivated, loose, friable condition where water can freely permeate the surface.
- .2 The date of Acceptance shall be as determined by the Owner's Representative base upon the Inspection for Acceptance. Contractor shall request inspection for Acceptance, giving at least 48 hours notice.

1.12 Warranty

- .1 Replace for a period of one (1) year after Substantial Performance of the project, all unsatisfactory plant material and continue to replace such plant material until the replacement is acceptable to the Owner's Representative, at no cost to the Owner. This warranty will apply to all plant material, whether supplied by Contractor or Owner.
- .2 This guarantee is based on adequate maintenance by the Owner after Acceptance. The Contractor will not be responsible for plant loss due to extreme climatic conditions such as abnormal freezing temperatures or hail which occur after Acceptance. The Contractor shall be responsible for plant loss due to inadequate acclimatization of plants for their planted location.

- .3 Adequacy of acclimatization and existence of extreme climatic conditions shall be as determined by an independent Owner's Representative on the basis of plant variety, location, recorded temperatures for the locale, time of planting and other factors pertinent to the situation.

1.13 Plant Material Replacements

- .1 The Contractor shall remove from the site and immediately replace any plant material that has been determined by the Owner's Representative to have died or failed to grow in a satisfactory manner during the warranty or maintenance period.
- .2 The Contractor shall extend the warranty on this replacement plant material for one (1) year from the date of replanting.
- .3 The Contractor shall continue such replacement and warranty of plant material until the Owner's Representative has determined that the 'Conditions for Final Acceptance' have been met.

1.14 Permits

- .1 Obtain and pay for all permits required for the work, including such permits as may be required for planting and related work on municipal property (e.g. street trees).

2 Products

2.1 General

- .1 Area of Search: Area of search for specified plant material shall include the Yukon and The Northwest Territories, unless otherwise approved or as noted on the plant list.
- .2 Provenance: All plant material used on this project shall be hardy in this climate. Plant types have been selected with this as a criteria. This Contractor shall guarantee that the plant material supplied has equal provenance, i.e.: it is developed from cuttings or seeds collected in an area of similar climatic characteristics. Submit proof of equal provenance to Owner's Representative upon request.
- .3 Plants or seeds are to be free of neonicotinoid (neonics) or other nicotinic Acetylcholine receptor agonists. Pesticides covered by this specification include but are not limited to clothianidin, dinotefuran, flupyradifurone, imidacloprid, thiamethoxam, sulfoxaflor, thiacloprid, and acetamiprid.

2.2 Plant Material

- .1 Plant material shall be of the sizes and quantities as shown in plant lists on Landscape Drawings and shall be nursery grown.
- .2 In particular, plant material shall conform to the following CNTA Standards:
 - .1 "Nursery stock shall be true to name, type and form and representative of their species or variety. In addition, they shall be of the size and grade and quality stated".
 - .2 "Quality shall be normal for the species when grown under proper cultural conditions viable, substantially free from pests and disease, and undamaged".
 - .3 "Roots shall not be subject to long exposure to drying winds, sun or frost, between digging and delivery".
 - .4 Root balls and soil in containers shall be free from pernicious perennial weeds."
 - .5 Roots shall be transplanted, or root pruned at least once within the year prior to planting.
 - .6 Take precautions during digging, handling and shipping of plant material to avoid injury to plants and root systems.

- .7 Plants for use when symmetry is required shall be matched as nearly as possible.
- .8 Plants shall not be pruned prior to delivery.
- .9 All plants shall be measured when the branches are in the normal position. Measurements shall be as set out in the CLS Standard for Container Grown Plants. Calliper of trees shall be measured 300mm (12 inches) above the ground.
- .10 Trees shall have straight trunks with a single leader intact. There shall be no abrasion of the bark and no fresh cuts of limbs over 30 mm (1-1/4") that have not completely calloused over.
- .11 Where trees are to be in a formal arrangement or occur in consecutive order, they shall be carefully measured as to height and spread and tagged with a number before delivery to the site. These trees shall be correspondingly identified on plan to assure symmetry and expeditious handling.
- .12 Plants larger in size than specified in the itemized plant list may be used if approved; but the use of larger plants shall not increase the Contract price. If the use of larger plants is approved, the ball of earth or spread of roots shall be increased in proportion to the size of the plant.
- .13 The size specified is the size of plant required at the time of delivery to the construction site. Sizes shown are minimum sizes.
- .3 Container dimensions shall be as defined in the Canadian Landscape Standard.
- .4 Type of root preparation, sizing, grading and quality: comply with the Canadian Landscape Standard, current edition.
- .5 Refer to detail drawings for specified plant materials and variations to typical species size and form.

2.3 Water

- .1 Free of impurities that would inhibit plant growth.
- .2 Contractor to ensure adequate water supply to plant material.

2.4 Tree Ties

- .1 Flat woven polypropylene material. 20 mm (3/4") wide, 544 Kg. (1200lb), break strength. Arbor Tie by Deep Root, or approved equal. Submit sample for approval to protect bark or other types approved by the Owner. Generally they shall be of a material that will not damage the bark. Tree tie material shall be at least 25mm (1") in width and shall remain pliable in all weather conditions. They shall permit a reasonable degree of movement by the tree under normal loading conditions/forces such as wind without detrimental effects. Rubber tree buckles, or galvanized wire with rubber hose will not be accepted.

2.5 Burlap

- .1 Shall be untreated, free from toxic contaminants and of sufficient strength to hold the rootball in a compact, stable mass that does not move relative to the main stem(s) of the tree or shrub.

2.6 Wire Baskets

- .1 Non-galvanized metal basket designed and manufactured for the purpose of tree moving. Basket shall be shaped to ensure that the root ball will allow a stable planting condition in accordance with standards noted.
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2.7 Mulch

- .1 9mm (3/8") Composted Mulch, black/brown in colour with no cedar or redwood bark or pre-approved equal.
- .2 10mm clean round river rock, sourced from local quarries. Provide sample for approval prior to install.

2.8 Anti-desiccant

- .1 Wax-like emulsion that will provide a transpiration reducing film over the plant surface. Moisturin by GSI Horticultural, Bend, Oregon, (541) 383-0222 or approved equal.

2.9 Tree Trunk Protection

- .1 Extrusion mold process, polyethylene with UV protectors: "Arborgard" manufactured by DeepRoot products Canada, Inc., or pre-approved equal.

2.10 Tree Guy Anchors/ Tree Guy System

- .1 Direct burial or screw type disc guy anchor and guy system. The Arrow Anchor by Tree-Guy/ Tree Guy System, Santa Anna, California (800) 624-1116, or approved equal.

2.11 Stakes and Stake Fasteners

- .1 Fir, standard or better, 75mm x 75mm x 3000mm long. Metal stake fasteners shall be hot dipped galvanized or stainless steel.

2.12 Flagging Tape

- .1 30mm (13/16") wide 'Red' PVC flagging tape or approved equal.

3 Execution

3.1 Planting Season

- .1 Plant only during the season or seasons that are normal for such work, as determined by weather conditions and as approved by the Owner's Representative. Plants planted before or after any stipulated dates will be rejected.
- .2 Do not plant during freezing, abnormally hot, dry, or wet weather or when damaging climatic conditions can be anticipated.
- .3 The Contractor will be responsible for death or deterioration of plants caused by exposure to damaging climatic conditions, planting under conditions itemized above or inadequate acclimatization of plant material.

3.2 Planting Schedule

- .1 All planting operations shall be done in a timely manner in accordance to the 'Planting Schedule'.
 - .2 'Planting Schedule' shall be updated as required by the Contractor to coincide with status of site and coordination with other trades. Provide the Owner's Representative with updates to the schedule as required throughout the planting process.
-

3.3 Delivery

- .1 Dig and handle all plant material in a manner suitable for each species to prevent injury to or removal of fibrous roots. All plant material delivered with broken or loose root balls or containers will be rejected by the Owner's Representative and replaced by the Landscape Contractor at no additional cost to the Owner.
- .2 Take precautions to avoid burning of plants by sun or wind during handling and transporting.
- .3 Keep root balls and container soil moist prior to delivery by covering with bark mulch, wet straw or soil and water as required to ensure moist root balls.
- .4 Coordinate the delivery of plant materials with work of other trades and other site activities.
- .5 Off load the plant materials at the site as designated by the Owner's Representative.
- .6 All plant material shall be acclimatized to the final location before delivery and planting. The Contractor will be held responsible for plant losses caused by inadequate acclimatization.

3.4 Plant Layout

- .1 Locate plants according to the Planting Plan for approval of plant location and orientation. Notify the Owner's Representative, giving 48 hours notice, when plant layout will be ready for review. At this time the Owner's Representative may adjust plant locations and orientation prior to planting.
- .2 Stake location of all major trees for approval to positioning. Notify the Owner's Representative at least 48 hours before planting of major trees. The Owner's Representative must be present during planting of major trees to ensure proper orientation and location.
- .3 Anti-desiccant shall be applied only as directed by the Owner's Representative. Application of anti-desiccant shall be in accordance with manufacturer's instructions.
- .4 Coordinate planting operations with other trades and project schedule.

3.5 Excavation

- .1 Existing Utilities: The Contractor is responsible for confirming the location and extent of existing utilities prior to the start of all planting operations. All attempts should be made to ensure that utility services are maintained to all on and off-site parties through out the entire planting operation.
- .2 For all trees, excavate tree pits with vertical sides, depth to be of sufficient size to contain root ball, min 600mm x 10m² surface area of growing medium or as detailed, directed by Owner's Representative.
- .3 Scarify the sides of tree pits.
- .4 Test all tree pits for poor drainage as directed by Owner's Representative. Fill each tree pit with a minimum of 20 litres (5 gallon) of water. Water should freely drain through subsoil within ten (10) minutes. If poor drainage or percolation is encountered report this condition immediately to the Owner's Representative for acceptable remedial measures. Measures such as auguring holes through the impervious layers and backfilling with approved clean rounded drain rock or sand, raising the planting grade, or adding dedicated drain lines connected to the subsurface drainage system will be considered.
 - .1 Notify Owner's Representative if tree pits in any soil condition do not drain freely or if tree pit fills with ground water.
 - .2 There shall be no standing water in the bottom of tree pit at time of planting.
- .5 Protect bottom of tree pit(s) against freezing.
- .6 Ensure tree pits and plant beds are kept well drained and free of contaminants and construction debris.

- .7 Excavate hole in growing medium sufficient to receive root ball. Excavation of the subgrade below the root balls of trees shall be only as necessary to permit the bottom of the root ball to sit on undisturbed material or compacted fill such that the top of the root ball remains at the proper finished grade. Disturbed subgrade or fill below the root ball shall be compacted to prevent settlement of the tree after planting. Remove excess material from the site.
- .8 Install root barrier adjacent to sidewalks, paths, parking lots and any other surfaces vulnerable to root heave.
- .9 Remove excavated subsoil material from site or use on site in an approved manner. Obtain prior approval from Owner's Representative.

3.6 Planting Procedure

- .1 Planting operations shall be carried out under conditions that are conducive to healthy, vigorous growth of plant material.
- .2 Planting operations shall not be carried out when the growing medium is frozen, mixed with ice and/or snow, saturated or compacted to levels that exceed this specification.
- .3 Plant material shall be planted vertical, straight and plumb at locations staked in field and or noted on landscape plans.
- .4 Ensure orientation of plant material will give best appearance in relation to views from adjacent buildings, roads, walks or use areas.
- .5 Install all plants at height grown in Nursery. Allow for settling of the growing medium after planting. The grade that the plant was grown in the nursery shall be used as the indicator for proper growing medium and plant elevation relationship. Top of root ball elevation shall match the elevation of adjacent growing medium elevation.
- .6 Plants shall be set plumb in the planting beds or in the center of the pits, except where the plant's character requires variation. Obtain approval from Owner's Representative.
- .7 Backfill around root ball with prepared growing medium, tamping and watering to ensure firm support for the plant and eliminating all air pockets around the root ball. Ensure water penetration into the root balls during planting procedures.
- .8 Remove all string, rope, burlap and other restricting elements out to the perimeter of the root ball. Cut all wire basket handles flush with the top ring or fold back down into the planting hole. Do not remove wire baskets. Ensure no wires from the basket protrude into the top 100mm of the growing medium.
- .9 Ensure a 150mm (6") deep saucer around all trees for the full width of the planting pit.

3.7 Fertilizer Application

- .1 Place fertilizer as per recommendations of soil analysis and to requirements of Section 32 91 13.

3.8 Tree Stabilization

- .1 Stake and Tie trees immediately after planting if specified and only as directed by the Owner's Representative. Trees damaged as a result of delayed staking shall be replaced.
 - .2 Trees shall stand plumb on completion of this operation.
 - .3 Stakes and ties shall be installed such that injury to bark will not occur.
 - .4 Ensure guy pins and stakes are placed out beyond the root ball. Trees that have had root balls penetrated by guy pins and stakes will be rejected.
 - .5 Tie one (1) to two (2) flagging tape flags to all guy wires at a height that is clearly visible.
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3.9 Tree Trunk Protection

- .1 Trees in lawn areas shall have trunk protection.
- .2 Place tree trunk protection around base of tree trunk as per manufacturer instructions.
- .3 Trees 100mm (4") calliper or less shall have one protector. Do not interlock ends of tree protector.
- .4 Trees greater than 100 mm (4") calliper shall have a minimum of two interlocked protectors. Do not interlock outside ends.

3.10 Tree Rings

- .1 Trees in lawn areas shall have 750mm (30") tree rings cut around the base of each tree. The tree rings shall be true circles centered on the trunk of the tree.
- .2 Have sod removed and area mulched as per specifications.
- .3 Trees in seeded areas shall have 750mm (30") tree rings cut around the base of each tree once seeded areas have been accepted by the Owner's Representative. The tree rings shall:
 - .1 Be true circles centered on the trunk of the tree.
 - .2 Have grass removed and area mulched as per specifications.

3.11 Pruning

- .1 Prune trees and shrubs after planting operation only as directed by Owner's Representative.
- .2 Prune only as directed by Owner's Representative.
- .3 Tree pruning is to be performed in accordance with the best practices published on the International Society of Arboriculture's (ISA) website (www.treesaregood.org).
- .4 Branch removal should be limited to necessary clearance pruning for public and electrical safety and the removal of dead, diseased, and/or defective wood to improve tree health and/or structure.
- .5 Street trees are to be pruned and maintained in accordance with Illuminating Engineering Society of North America (IES) standards for Roadway Lighting.
- .6 Each shrub planted shall be pruned to preserve the natural character of the plant and in a manner appropriate to its particular requirements in the landscape design.
- .7 All soft wood sucker growth and all broken or badly bruised branches shall be removed with a clean cut.
- .8 All pruning shall be done with proper, sharp pruning tools. All pruning cuts to be made protecting the branch collar.
- .9 All pruning cuts shall be made with pruning saws or hook and blade pruning tools designed and manufactured for pruning operations. Anvil-type pruning tools shall not be used in any pruning operations.
- .10 Do not damage the branch collar.
- .11 Do not damage the leader or lead branches. Plants which have had the main leader or lead branches damaged or removed will be rejected and replaced by the Contractor at no cost to the Owner.
- .12 Do not remove minor twig branches along the main structural branches.

3.12 Applying Mulch

- .1 Prior to the application of mulch;
 - .1 Reset all plants that have settled so that relationship of nursery grade of root ball to finish grade of growing medium is as per specification
 - .2 Manually remove all weeds and weed roots from root balls and adjacent growing medium.
 - .3 Remove all deleterious material and debris from planting areas.

- .4 All fine grading is complete, the growing medium is loose and friable
 - .5 The Owner's Representative has reviewed of all planting areas.
-
- .2 Spread composted mulch to minimum depth of 50 mm (2").
 - .1 Ensure finish composted mulch layer is a minimum of 12mm (1/2") below adjacent hard landscape surfaces and edges.
 - .2 Ensure mulch is kept 125 mm (5") away from tree trunks and 75 mm (3") away from stems of shrubs.

3.13 Maintenance

- .1 Begin maintenance at time of planting and continue for a minimum of fifty-five (55) days or until Acceptance which ever is greater, at which time the Owner will take over maintenance.
- .2 If for any reason the Contractor elects, on his own without the written consent of the Owner's Representative to suspend maintenance operations they are to provide the Owner's Representative written notice of such action. Any damages or requirement for the replacement of plant material that as a result of the suspension of maintenance operations shall be the borne by the Contractor at no cost to the Owner.
- .3 Maintenance of plant material includes but is not limited to watering at intervals sufficient to maintain healthy, vigorous growth, weeding of plant beds and tree pits, cultivating of growing medium, pruning, only if requested, treatment of insects, moulds, fungi or disease to the Level 2 "Groomed" as per the BCNLA Landscape Standard, Current Edition or as directed by Owner's Representative.
- .4 Plant material shall be deep watered at least once per day when temperatures exceed 25 degrees Celsius (77 degrees F).
- .5 Contractor to ensure adequate moisture in plant root zone prior to winter freeze-up.
- .6 Ensure tree guards, stakes, flagging tape on tree guy wire and tree ties are kept secure, taught and in proper repair.

3.14 Finish Grading

- .1 All planted areas and all growing medium shall be fine graded after placing to the finished elevations and contours as detailed and specified herein. Surfaces shall be true to intended grades, smooth, uniform, and firm against deep foot printing, with a fine loose surface texture. Ensure all rough spots and low areas are eliminated to ensure positive surface drainage. Adjust grades to accommodate for mulch as specified/detailed.

3.15 Cleaning

- .1 All excess materials and other debris resulting from planting operations shall be removed from the job site.
- .2 Flush all walks and paved areas and rake all lawn areas clean to the satisfaction of the Owner's Representative.

END OF SECTION 32 92 00

Part 1 GENERAL

1.1 General Requirements

- .1 Refer to Division 1, General Requirements
- .2 This section of the specification forms an integral part of the Contract Documents and is to be read, interpreted, and coordinated with all the other parts.

1.2 Description

- .1 Supply all products, labour, equipment, and services necessary to install plant material as indicated in the contract documents.

1.3 Related Work

- .1 Section 32 01 90 – Landscape Maintenance
- .2 Section 32 91 13 – Growing Medium
- .3 Section 32 91 00 – Site Preparation and Grading

1.4 Reference Standards

- .1 Conform to the requirements of the latest editions of the following standards and legislation:
 - .1 CLS / Canadian Landscape Standard
 - .2 Canadian System of Soil Classification
 - .3 Canadian National Master Construction Specification

1.5 Quality Assurance

- .1 The contractor must have experience at performing this type and scale of work and must be willing to provide proof of this experience.
- .2 Cut sod by approved methods in accordance with recommendations of the Canadian Nursery Trades Association (CNTA).
- .3 Protect sod during transportation to prevent drying out and to ensure its arrival at site in a fresh and healthy condition.
- .4 Sod should be installed upon arrival. If there is a delay in installation due to weather, keep the sod moist and cool and protected from direct exposure to sun until installation.
- .5 Do not deliver small, irregular, or broken pieces of sod.
- .6 Schedule sod laying to coincide with topsoil operations.

1.6 Delivery, Storage and Handling

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
 - .1 Store materials in accordance with supplier's recommendations.
 - .2 Replace defective or damaged materials with new.

Part 2 PRODUCTS

2.1 Materials

- .1 Quality and source to comply with standard outlined in "Metric Guide Specification for Nursery Stock, Section 17" published by Canadian Nursery Trades Association.
- .2 Locally grown nursery sod.
- .3 Water:
 - .1 Clean, potable water from a source approved by the Owner's Representative.
 - .2 Free of impurities that would inhibit plant growth.
- .4 Fertilizer:
 - .1 12-25-10 fertilizer, may be amended per soil test results.
- .5 Wood Pegs:
 - .1 17 mm x 17 mm x 250 mm (5/8" x 5/8" x 10") or approved 200 mm (8") long steel staples.

2.2 Source quality control

- .1 Obtain written approval from Owner's Representative of sod at source.
- .2 When proposed source of sod is approved, use no other source without written authorization from Owner's Representative.

Part 3 EXECUTION

3.1 Preparation

- .1 Obtain approval of sod bed finish grade and depth before starting sodding.
- .2 Lay sod during growing season. Laying sod at freezing temperatures or over frozen soil is unacceptable
- .3 Fine grade surface free of humps and hollows to smooth, even grade, surface to drain naturally.
- .4 Remove and dispose of weeds; debris; stones; soil contaminated by oil, gasoline and other deleterious materials.

3.2 Sod Placement

- .1 Lay sod with tight butt joints. Do not leave any open joints or overlap adjacent pieces of sod. Ensure that adjacent rows are laid in a staggered sequence.
- .2 Lay sod sections in rows, joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with sharp implements.
- .3 Provide close contact between sod and soil by light rolling. Use of heavy roller to correct irregularities in grade is not permitted.
- .4 Water immediately after sod laying to obtain moisture penetration through sod into top 100 mm (4") of topsoil.
- .5 Provide adequate protection of sodded areas against erosion and mechanical damage. Remove protection after sodded areas have been accepted.
- .6 Top dress sodded areas as required with friable and clean topsoil having high humus content.

- .7 Overseed top dressed area using 1 kg (21 lbs.) grass seed per 100 m² (1,000 ft.²) with seed mixture of 50% Kentucky Bluegrass and 50% Creeping Red Fescue.

3.3 Sod Placement on Slopes and Pegging

- .1 Start laying sod at bottom of slopes.
- .2 On slopes steeper than 3H:IV lay sod across the face of the slope and peg each row at intervals of not more than 600 mm.

3.4 Fertilizing program

- .1 Apply 12-25-10 fertilizer at 400 kg/ha. This is subject to adjustment as per soil test.

3.5 Cleaning

- .1 Progress Cleaning: Leave Work area clean at end of each day.
- .1 Broom clean pavement and sidewalks. Clear soil and rubble from underground or surface storm surface lids, shrubs, signage fences and the like.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.6 Maintenance

- .1 Apply water in sufficient quantities for grass to flourish.
- .2 Cut grass the first time when it reaches height of 60 mm, and maintain to minimum height of 60 mm. Do not cut more than 30% of the blade at any one mowing.
- .3 Repair areas which show root growth failure, deterioration, bare or thin spots or which have been damaged by any means, including replacement operations.
- .4 Maintain sodded areas until acceptance of the project.
- .5 Sodded areas will be accepted at final inspection provided that:
 - .1 Sodded areas are properly established.
 - .2 Sod is free of bare and dead spots and without weeds.

END OF SECTION 32 92 23

Part 1 General

1.1 REFERENCE STANDARDS

- .1 City of Whitehorse Servicing Standards Manual - Section 2.3 – Water Distribution System and Section 2.6 – Sewer and Water Service Connections
- .2 Department of Justice Canada (Jus):
 - .1 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations
- .3 American National Standards Institute/American Water Works Association (ANSI/AWWA):
 - .1 [ANSI/AWWA B300-18](#), Standard for Hypochlorites
 - .2 [ANSI/AWWA B301-18](#), Liquid Chlorine
 - .3 [ANSI/AWWA B303-18](#), Sodium Chlorite
 - .4 [ANSI/AWWA C104/A21.4-16](#), Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
 - .5 [ANSI/AWWA C105/A21.5-18](#), Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
 - .6 [ANSI/AWWA C110/A21.10-12](#), Ductile-Iron and Gray-Iron Fittings
 - .7 [ANSI/AWWA C111/A21.11-17](#), Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 - .8 [ANSI/AWWA C150/A21.50-14](#), Standard for Thickness Design of Ductile-Iron Pipe
 - .9 [ANSI/AWWA C151/A21.51-17](#), Standard for Ductile-Iron Pipe, Centrifugally Cast
 - .10 [ANSI/AWWA C153/A21.53-19](#), Standard for Ductile-Iron Compact Fittings
 - .11 [ANSI/AWWA C200-17](#), Standard for Steel Water Pipe - 6 Inch (150 mm) and Larger
 - .12 [ANSI/AWWA C203-20](#), Standard for Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
 - .13 [ANSI/AWWA C205-18](#), Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inch (100 mm) and Larger - Shop Applied
 - .14 [ANSI/AWWA C206-17](#), Standard for Field Welding of Steel Water Pipe
 - .15 [ANSI/AWWA C207-18](#), Standard for Steel Pipe Flanges for Waterworks Service, 4 Inch through 144 Inch (100 mm through 3,600 mm)
 - .16 [ANSI/AWWA C208-17](#), Standard for Dimensions for Fabricated Steel Water Pipe Fittings
 - .17 [ANSI/AWWA C300-16](#), Standard for Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
 - .18 [ANSI/AWWA C301-14](#), Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
 - .19 [ANSI/AWWA C303-17](#), Standard for Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
 - .20 [ANSI/AWWA C500-19](#), Standard for Metal-Seated Gate Valves for Water Supply Service

- .21 [ANSI/AWWA C504-15](#), Standard for Rubber-Seated Butterfly Valves
- .22 [ANSI/AWWA C600-17](#), Standard for Installation of Ductile-Iron Water Mains, and Their Appurtenances
- .23 [ANSI/AWWA C602-17](#), Standard for Cement-Mortar Lining of Water Pipelines - 4 Inch (100 mm) and Larger
- .24 [ANSI/AWWA C651-14](#), Standard for Disinfecting Water Mains
- .25 [ANSI/AWWA C800-21](#), Standard for Underground Service Line Valves and Fittings
- .26 [ANSI/AWWA C900-16](#), Standard for Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 Inch through 12 Inch (100 mm - 300 mm), for Water Transmission and Distribution
- .4 ASTM International (ASTM):
 - .1 [ASTM A53/A53M-20](#), Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
 - .2 [ASTM A123/A123M-13](#), Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - .3 [ASTM A307-21](#), Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 psi Tensile Strength
 - .4 [ASTM B88M-20](#), Standard Specification for Seamless Copper Water Tube (Metric)
 - .5 [ASTM C117-17](#), Standard Test Method for Materials Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing
 - .6 [ASTM C136/C136M-19](#), Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - .7 [ASTM C478/C478M-20](#), Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
 - .8 [ASTM C618-19](#), Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
 - .9 [ASTM D698-12](#), Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - .10 [ASTM D2310-06](#), Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
 - .11 [ASTM D2657-07](#), Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
 - .12 [ASTM D2992-18](#), Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
 - .13 [ASTM D2996-17](#), Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
 - .14 [ASTM F714-21](#), Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
- .5 American Water Works Association (AWWA)/Manual of Practice:
 - .1 [AWWA M9-2008](#), Concrete Pressure Pipe
 - .2 [AWWA M11-2018](#), Steel Pipe - A Guide for Design and Installation

- .3 [AWWA M17-2016](#), Installation, Field Testing, and Maintenance of Fire Hydrants
- .6 Canadian General Standards Board (CGSB):
 - .1 [CAN/CGSB-8.1-88](#), Sieves, Testing, Woven Wire, Inch Series
 - .2 [CAN/CGSB-8.2-M88](#), Sieves, Testing, Woven Wire, Metric
 - .3 [CGSB 41-GP-25M-77](#), Pipe, Polyethylene, for the Transport of Liquids
- .7 CSA Group (CSA):
 - .1 [CAN/CSA-A257](#) Series:19, Standards for Concrete Pipe (Consists of A257.0, A257.1, A257.2, A257.3 and A257.4)
 - .2 [CAN/CSA-A3000-18](#), Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005)
 - .3 [CAN/CSA-B137:20](#) Series, Thermoplastic Pressure Piping Compendium (Consists of B137.0, B137.1, B137.2, B137.3, B137.4, B137.4.1, B137.5, B137.6, B137.8, B137.9, B137.10, B137.11 and B137.12)
 - .4 [CSA G30.18-09](#), Carbon and Steel Bars for Concrete Reinforcement
- .8 The Master Painters Institute (MPI):
 - .1 Architectural Painting Specification Manual, current edition
- .9 ULC Standards (ULC):
 - .1 [CAN/ULC-S520:2016](#), Standard for Fire Hydrants
 - .2 [CAN/ULC-S543-09](#), Standard for Internal-Lug, Quick Connect Couplings for Fire Hose

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Schedule Work to minimize interruptions to existing services.
 - .1 Submit schedule of expected interruptions for approval and adhere to interruption schedule as approved by Consultant.
 - .2 Notify Client and Consultant minimum of 72 hours in advance of interruption in service.
 - .3 Do not interrupt water service for more than 3 hours and confine this period between 10:00 and 16:00 hours local time unless otherwise authorized.
 - .4 Notify fire department of planned or accidental interruption of water supply to hydrants.
 - .5 Provide and post "Out of Service" sign on hydrant not in use.
 - .6 Advise local police department of anticipated interference with movement of traffic.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, product literature and data sheets for distribution piping materials and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Pipe certification to be on pipe.

- .3 Shop Drawings: submit complete drawings and construction schedule for water mains 100mm diameter and larger. Include method for installation of water main.
- .4 Samples:
 - .1 Inform Consultant of proposed source of bedding materials and provide access for sampling at least 4 weeks before commencing work.
 - .2 Submit for testing 4 weeks minimum before beginning work, samples of materials proposed for use as follows:
 - .3 Submit manufacturer's test data and certification that pipe materials meet requirements of this section 4 weeks minimum before beginning work. Include manufacturer's drawings, information and shop drawings where pertinent.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Operation and Maintenance Data: Submit operation and maintenance data for pipe, valves, valve boxes, valve chambers and hydrants for incorporation into manual.
- .3 Submit data to produce record drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of air and vacuum release valves, hydrant details.
 - .1 Include top of pipe, horizontal location of fittings and type, valves, valve boxes, valve chambers and hydrants.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions in original factory packing labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect water distribution piping from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 00 10 - General Requirements.
- .2 Tools: provide tools as follows:
 - .1 2 service post wrenches for curb stops.
 - .2 1 hydrant wrenches.
 - .3 2 tee-handle operating keys for valves.

Part 2 Products

2.1 PIPE, JOINTS, AND FITTINGS

- .1 Polyethylene pressure pipe:
 - .1 Water service pipe is to be HDPE DR11 and is to be provided with a factory-applied 50 mm thick insulation and waterproof jacket.
 - .2 All joints in service are to be fused. Compression joints are not acceptable.

2.2 PIPE INSULATION

- .1 Water utility distribution piping is to be insulated using a factory applied, rigid foam material with specifications as follows:

Density	35.2 kg/m ³ minimum ASTM D1622
Closed cell content	90 % minimum ASTM D2856
Water Absorption	4.0 % by Volume ASTM D2842-69
Thermal Conductivity	0.023 W/m @ 22 degrees Celsius ASTM C518
System Compressive Strength	Modified ASTM D1621 with 50 mil Jacket. Approximately 414 to 522 kPa, varies with pipe diameter
Thickness	Minimum 50 mm

- .2 Insulated water utility distribution piping shall have a jacket using high-density polyethylene carbon black, factory applied by continuous extrusion or approved tape-wrap method, specified as follows:

Tape Jacket Material	Polyethylene UV inhibited, formulated for superior cold weather properties (to -45 degrees Celsius)
Sealant	Butyl rubber and resin
Tensile Strength	21 MPa minimum (ASTM D1000) 8.93 kg/cm width
Thickness	1.14 mm minimum for extruded polyethylene or 2 cross wraps for a minimum of 1.27 mm for tape-wrapped polyethylene application.

- .3 The pipe is to be located at the center of the insulation material. An allowable tolerance on this is as follows:
- .1 Total diameter of insulation pipe structure is in no instance to be less than the pipe diameter plus 100 mm.
 - .2 The minimum thickness of insulation at any location of the pipe is to be 50 mm.
- .4 The Contractor is to provide suitable tape and is to tape-wrap all locations where such test is performed. Materials, which do not comply with the specification, will be rejected.
- .5 The Consultant is to reserve the right to have representatives present at the installation applicators plant during insulation application. The Contractor is to provide a schedule to the Consultant indicating when the application will take place.
- .6 The pipe joints and fittings are to be insulated with a minimum 50 mm polyethylene half shell or where necessary use approved field insulation kits. Protect insulation with polyethylene heat-shrink sleeve or a triple overlapping wrap of suitable heat-shrinking tape.
- .7 Joints on services shall not be taped. Contractor to coat the exposed insulation at the end of the pie with tar. When compression couplings are used for connection, one end of the half-shell is to be taped to the pipe. The other end of the half shell shall be coated with tar and left untaped.
- .8 Styrofoam board insulation is to be installed as/if demonstrated on drawings. Insulation is to be extruded polystyrene with a minimum compressive strength of 35 psi or better. Install using interlocking pieces or overlap sheets 50 mm. Styrofoam board insulation is not a substitute for factory applied insulation or half shells as described above.

2.3 VALVES AND VALVE BOXES

- .1 Valves to open counter clockwise.

- .2 Gate valves: to [ANSI/AWWA C500](#), standard iron body, brass mounted wedge valves with non-rising stems, suitable for 1 Pa with mechanical joints.
- .3 Butterfly valves: to [ANSI/AWWA C504](#), long body, class 1MPa with mechanical joints.
- .4 Underground type indicator valve where indicated. Indicator post to accurately indicate valve open or closed. Valve to be electrically supervised.
- .5 Air and vacuum release valves: heavy duty combination air release valves employing direct acting kinetic principle.
 - .1 Fabricate valves of cast iron body and cover, with bronze trim, stainless steel floats with shock-proof synthetic seat suitable for 2MPa working pressure.
 - .2 Valves to expel air at high rate during filling, at low rate during operation, and to admit air while line is being drained.
 - .3 Valve complete with surge check unit.
 - .4 Ends to be flanged to [ANSI/AWWA C110/A21.10](#).
- .6 Cast iron valve boxes: bituminous coated screw type adjustable over minimum of 450mm complete with valve operating extension rod, 25 x 25 mm cross section, of such length that when set on valve operating nut top of rod will not be more than 150 mm below cover.
 - .1 Base to be large round type with minimum diameter of 300mm.
 - .2 Top of box to be marked "WATER"/"EAU".

2.4 SERVICE CONNECTIONS

- .1 Polyethylene pressure pipe:
 - .1 To [ASTM F714](#), , Type PE, series DR 11.
- .2 Polyethylene pipe joints: thermal butt fusion welded.
- .3 Corporation main stops are to be Cambridge Brass, Mueller, Ford Meter Box FB1000-Q-NL or approved equal, installed with HDPE inserts.
- .4 Curb stops (CC's) are to be Cambridge Brass Model 203, Mueller H15219, or Ford Meter Box B44-NL or approved equal installed with HDPE inserts.
- .5 Curb boxes are to be Mueller A-726 for 20 or 25 mm services or Mueller A-728 for 30 to 50 mm services, cast iron extension type with A-800 lids, or approved equal, with 600 mm telescoping upper box and stainless steel CC key. Stationary rods are to be provided.
- .6 Water pipe saddles to be installed are to be Robar 2706 double strap saddles, or approved equal, manufactured to the type of main being tapped.
- .7 Refer to standard details in the Civil drawings for the project.

2.5 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Bedding Sand as indicated and to gradations and compaction specified in Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Concrete mixes and materials required for bedding cradles, encasement, supports, thrust blocks: to Section 03 30 00.50 - Cast-in-Place Concrete - Civil.

2.6 BACKFILL MATERIAL

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 80 mm Pit Run Gravel and 20 mm Basecourse Gravel to gradations as indicated and to gradations and compaction specified in Section 32 11 23 - Aggregate Base Courses and Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.7 PIPE DISINFECTION

- .1 Sodium hypochlorite to [ANSI/AWWA B300](#) to disinfect water mains.
- .2 Disinfect water mains in accordance with [ANSI/AWWA C651](#).
- .3 In accordance with City of Whitehorse Servicing Standards Manual

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: Verify that conditions of substrates previously installed under other Sections or Contracts are acceptable for distribution piping installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrates in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 PREPARATION

- .1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation.
 - .1 Inspect materials for defects to approval of Consultant.
 - .2 Remove defective materials from site as directed by Consultant.

3.3 TRENCHING

- .1 Do trenching work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Ensure trench depth allows coverage over pipe of 1.2 m minimum from finished grade or as indicated.
- .3 Trench alignment and depth require Consultant's approval before placing bedding material and pipe.

3.4 CONCRETE BEDDING AND ENCASEMENT

- .1 Do concrete work in accordance with Section 03 30 00.50 - Cast-in-Place Concrete - Civil.
 - .1 Place concrete to details as indicated.
- .2 Pipe may be positioned on concrete blocks to facilitate placing of concrete. When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.
- .3 Do not backfill over concrete within 24 hours after placing.

3.5 GRANULAR BEDDING

- .1 Place granular bedding material in uniform layers not exceeding 150mm compacted thickness to depth as indicated.
- .2 Do not place material in frozen condition.
- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to compaction requirements specified in Section 31 23 33.01 - Excavating, Trenching and Backfilling and the project specific Geotechnical Report issued by Tetra Tech on December 20, 2022.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling with compacted bedding material.

3.6 PIPE INSTALLATION

- .1 Terminate building water service 1 m outside building wall opposite point of connection to main.
 - .1 Install coupling necessary for connection to building plumbing.
 - .2 If plumbing is already installed, make connection; otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Lay pipes to ANSI/AWWA and manufacturer's standard instructions and specifications.
 - .1 Do not use blocks except as specified.
- .3 Join pipes in accordance with AWWA and manufacturer's recommendations.
- .4 Handle pipe by methods recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.
- .5 Lay pipes on prepared bed, true to line and grade.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - .2 Take up and replace defective pipe.
 - .3 Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10mm in 3m.
- .6 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- .7 Keep jointing materials and installed pipe free of dirt and water and other foreign materials.
 - .1 Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .8 Position and join pipes with equipment and methods approved by Consultant.
- .9 Cut pipes in approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .10 Align pipes before jointing.
- .11 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.

- .12 Avoid displacing gasket or contaminating with dirt or other foreign material.
 - .1 Remove disturbed or contaminated gaskets.
 - .2 Clean, lubricate and replace before jointing is attempted again.
- .13 Complete each joint before laying next length of pipe.
- .14 Minimize deflection after joint has been made.
- .15 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- .16 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Consultant.
- .17 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
- .18 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- .19 Do not lay pipe on frozen bedding.
- .20 Do hydrostatic and leakage test and have results approved by Consultant before surrounding and covering joints and fittings with granular material.
- .21 Backfill remainder of trench.

3.7 VALVE INSTALLATION

- .1 Install valves to manufacturer's recommendations at locations as indicated.
- .2 Support valves located in valve boxes or valve chambers by means of compacted granular bedding same as adjacent pipe. Valves not to be supported by pipe.
- .3 Install underground post-type indicator valves as indicated.

3.8 UNDERCROSSING

- .1 Excavate working pit to dimensions indicated, outside right-of-way to be crossed.
- .2 Excavate working pit to minimum of 0.5 m below lowest invert of crossing pipes.
- .3 Dewater excavation.
- .4 Dewater area of undercrossing.
- .5 Provide shop drawings showing proposed method of installation for sanitary sewer in undercrossing.
- .6 Couplings of water main: not to rest on levelling pad when water main is in position.
- .7 Place 20MPa concrete cradle around water main after it is positioned.
 - .1 Cradle to be minimum of 225mm and maximum of 300mm above levelling pad.
- .8 Pressure grout remaining void with grout consisting of 1 part Portland cement and 2 parts clean washed sand with only sufficient amount of water added to allow placement.
 - .1 Do not install pressure grout until water main is secure against flotation.
 - .2 Do not use additives.
- .9 Do site testing before placing concrete cradle and grouting.

3.9 SERVICE CONNECTIONS

- .1 Terminate building water service as indicated in Drawings.
 - .1 Install coupling necessary for connection to building plumbing.
 - .2 If plumbing is already installed, make connection, otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Do not install service connections until satisfactory completion of hydrostatic and leakage tests of water main.
- .3 Construct service connections at right angles to water main unless otherwise directed. Locate curb stops 300mm inside roadway allowance.
- .4 Tappings for PE pipe: PE tapping tees or multi-saddle tees.
- .5 Employ only competent workmen equipped with suitable tools to carry out tapping of mains, cutting and flaring of pipes.
- .6 Install single and multiple tap service connections on top half of main, between 45 degrees and 90 degrees measured from apex of pipe.
- .7 Install multiple corporation stops, 30 degrees apart around circumference of pipe and minimum of 300mm apart along pipe.
- .8 Tap main at 2:00 o'clock or 10:00 o'clock position only; not closer to joint nor closer to adjacent service connections than recommended by manufacturer, or 1 m minimum, whichever is greater.
- .9 Leave corporation stop valves fully open.
- .10 In order to relieve strain on connections, install service pipe in "Goose Neck" form "laid over" into horizontal position.
- .11 Install rigid stainless steel liners in small diameter plastic pipes with compression fittings.
- .12 Install curb stop with corporation box on services NPS 2 or less in diameter.
 - .1 Equip larger services with gate valve and cast iron box.
 - .2 Set box plumb over stop and adjust top flush with final grade elevation.
 - .3 Leave curb stop valves fully closed.
- .13 Place temporary location marker at ends of plugged or capped unconnected water lines.
 - .1 Each marker to consist of 38 x 89mm stake extending from pipe end at pipe level to 600mm above grade.
 - .2 Paint exposed portion of stake red with designation "WATER SERVICE LINE" in black.

3.10 THRUST BLOCKS AND RESTRAINED JOINTS

- .1 For thrust blocks: do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated or as directed by Consultant.
- .3 Keep joints and couplings free of concrete.
- .4 Do not backfill over concrete within 24 hours after placing.
- .5 For restrained joints: only use restrained joints approved by Consultant.

3.11 HYDROSTATIC AND LEAKAGE TESTING

- .1 Do tests in accordance with ANSI/AWWA C600.
- .2 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.
- .3 Notify Consultant at least 72 hours in advance of proposed tests.
 - .1 Perform tests in presence of Consultant.
- .4 Where section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete or 2 days if high early strength concrete is used.
- .5 Test pipeline in sections not exceeding 365m in length, unless otherwise authorized by Consultant.
- .6 Upon completion of pipe laying and after Consultant has inspected Work in place, surround and cover pipes between joints with approved granular material placed to dimensions indicated.
- .7 Leave hydrants, valves, joints and fittings exposed.
- .8 When testing is done during freezing weather, protect hydrants, valves, joints and fittings from freezing.
- .9 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.
- .10 Open valves.
- .11 Expel air from main by slowly filling main with potable water.
 - .1 Install corporation stops at high points in main where no air-vacuum release valves are installed.
 - .2 Remove stops after satisfactory completion of test and seal holes with plugs.
- .12 Fill concrete pipe at least 24 hours before testing to allow water absorption by pipe material.
- .13 Thoroughly examine exposed parts and correct for leakage as necessary.
- .14 Apply hydrostatic/leakage test pressure of 700 kPa minimum based on elevation of lowest point in main and corrected to elevation of test gauge, for period of 2 hours.
- .15 Examine exposed pipe, joints, fittings and appurtenances while system is under pressure.
- .16 Remove joints, fittings and appurtenances found defective and replace with new sound material and make watertight.
- .17 Repeat hydrostatic test until defects have been corrected.
- .18 Do not exceed allowable leakage of 1.0 L/mm (diameter) per kilometer of pipe per day, including lateral connections.
- .19 Locate and repair defects if leakage is greater than amount specified.
- .20 Repeat test until leakage is within specified allowance for full length of water main.

3.12 PIPE SURROUND

- .1 Upon completion of pipe laying and after Consultant has inspected Work in place, surround and cover pipes as indicated.

- .2 Hand place surround material in uniform layers not exceeding 150mm compacted thickness as indicated.
 - .1 Do not dump material within 1 m of pipe.
- .3 Place layers uniformly and simultaneously on each side of pipe.
- .4 Do not place material in frozen condition.
- .5 Compact each layer from pipe invert to underside of backfill for the full width of the bed in accordance with compaction requirements in Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.13 BACKFILL

- .1 Place backfill material, above pipe surround, in uniform layers not exceeding 150mm compacted thickness up to grades as indicated.
- .2 Do not place backfill in frozen condition.
- .3 Compact each layer for the full width of the bed in accordance with compaction requirements in Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.14 FLUSHING AND DISINFECTING

- .1 Flushing and disinfecting operations: witnessed by Consultant.
 - .1 Notify Consultant at least 4 days in advance of proposed date when disinfecting operations will begin.
- .2 Flush water mains through available outlets with a sufficient flow of potable water to produce velocity of 1.5m/s, within pipe for minimum 10 minutes, or until foreign materials have been removed and flushed water is clear.
- .3 Flushing flows as follows:
 - .1

Pipe Size NPS	Flow (L/s) Minimum
6 and below	38
8	75
10	115
12	150

- .4 Provide connections and pumps for flushing as required.
- .5 Open and close valves, hydrants and service connections to ensure thorough flushing.
- .6 When flushing has been completed to Consultant approval, introduce strong solution of chlorine as approved by Consultant.
- .7 Disinfect water mains to the requirements of local authority.
- .8 Rate of chlorine application to be proportional to rate of water entering pipe.
- .9 Chlorine application to be close to point of filling water main and to occur at same time.
- .10 Operate valves, hydrants and appurtenances while main contains chlorine solution.
- .11 Flush line to remove chlorine solution after 24 hours.
- .12 Measure chlorine residuals at extreme end of pipe-line being tested.
- .13 Perform bacteriological tests on water main, after chlorine solution has been flushed out.

- .1 Take samples daily for minimum of 2days.
- .2 Should contamination remain or recur during this period, repeat disinfecting procedure.
- .3 Specialist contractor to submit certified copy of test results.
- .14 Take water samples at hydrants and service connections, in suitable sequence, to test for chlorine residual.
- .15 After adequate chlorine residual not less than 50 ppm has been obtained leave system charged with chlorine solution for 24hours.
 - .1 After 24hours, take further samples to ensure that there is still not less than 10ppm of chlorine residual remaining throughout system.

3.15 SURFACE RESTORATION

- .1 After installing and backfilling over water mains, restore surface to original condition as directed by Consultant.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 30 00.50 - Cast-in-Place Concrete - Civil
- .2 Section 31 05 16 - Aggregate Materials
- .3 Section 31 23 33.01 - Excavating, Trenching and Backfilling

1.2 REFERENCE STANDARDS

- .1 City of Whitehorse Servicing Standards Manual - Section 2.4 – Sanitary Sewer System and Section 2.6 – Sewer and Water Service Connections.
- .2 Departmental of Justice Canada (Jus):
 - .1 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations
- .3 American National Standards Institute/American Water Works Association (ANSI/AWWA):
 - .1 [ANSI/AWWA C111/A21.11- 17](#), Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
- .4 ASTM International (ASTM):
 - .1 [ASTM C12- 21](#), Standard Practice for Installing Vitrified Clay Pipe Lines
 - .2 [ASTM C14M- 20](#), Standard Specification for Nonreinforced Concrete Sewer, Storm Drain and Culvert Pipe (Metric)
 - .3 [ASTM C76M- 20](#), Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe (Metric)
 - .4 [ASTM C117- 17](#), Standard Test Method for Material Finer Than 75 MUm (No. 200) Sieve in Mineral Aggregates by Washing
 - .5 [ASTM C136/C136M- 19](#), Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - .6 [ASTM C425- 21](#), Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
 - .7 [ASTM C443M- 20](#), Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
 - .8 [ASTM C700- 13](#), Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
 - .9 [ASTM C828- 11](#), Standard Test Method for Low-pressure Air Test of Vitrified Clay Pipe Lines
 - .10 [ASTM D698- 12](#), Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft⁴-lbf/ft³ (600 kN-m/m³))
 - .11 [ASTM D2680- 20](#), Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping
 - .12 [ASTM D3034- 16](#), Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
 - .13 [ASTM D3350- 21](#), Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

- .5 Canadian General Standards Board (CGSB):
 - .1 [CAN/CGSB-8.1-88](#), Sieves, Testing, Woven Wire, Inch Series
 - .2 [CAN/CGSB-8.2-M88](#), Sieves, Testing, Woven Wire, Metric
- .6 CSA Group (CSA):
 - .1 [CSA A257](#) Series: 19, Standards for Concrete Pipe and Manhole Sections [CSA A3000](#)- 18, Cementitious Materials Compendium
 - .2 [CAN/CSA-B70](#): 19, Cast Iron Soil Pipe, Fittings, and Means of Joining
 - .3 [CSA B1800](#)- 15, Thermoplastic Non-pressure Pipe Compendium
 - .1 [CSA B182.1](#)- 15, Plastic Drain and Sewer Pipe and Pipe Fittings
 - .2 [CSA B182.2](#)- 15, PSM Type Polyvinylchloride PVC Sewer Pipe and Fittings
 - .3 [CSA B182.6](#)- 15, Profile Polyethylene (PE) Sewer Pipe and Fittings for Leak-Proof Sewer Applications
 - .4 [CSA B182.11](#)- 15, Standard Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Fittings

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling:
 - .1 Schedule Work to minimize interruptions to existing services and maintain existing sewage flows during construction.
 - .2 Submit schedule of expected interruptions for approval and adhere to approved schedule.
 - .3 Notify Consultant and building 72 hours minimum in advance of any interruption in service.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for pipes, and backfill and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Yukon Territory, Canada.
 - .2 Indicate on drawings proposed method for installing carrier pipe for undercrossings.
- .4 Samples:
 - .1 Inform Consultant at least 4 weeks before beginning Work, of proposed source of bedding materials and provide access for sampling.
- .5 Certificates:
 - .1 Certification to be marked on pipe.
- .6 Test and Evaluation Reports:

- .1 Submit manufacturer's test data and certification 2 weeks minimum before beginning Work.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements
- .2 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect pipes from damage.
- .4 Packaging Waste Management: Remove for reuse and return of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 PLASTIC PIPE

- .1 Type PSM Polyvinyl Chloride (PVC): To [ASTM D3034](#).
 - .1 Standard Dimensional Ratio (SDR): 35.
 - .2 Locked-in gasket and integral bell system.
 - .3 Nominal lengths: 6 m

2.2 SERVICE CONNECTIONS

- .1 Type PSM Poly (Vinyl) Chloride: To [CSA B182.2](#).
- .2 Plastic pipe: To [CSA B182.1](#), with push-on joints.
- .3 Cast iron service saddles: With oil resistant gaskets, stainless steel clamp and oil resistant "O" rings in branch end.

2.3 CEMENT MORTAR

- .1 Portland cement: To [CSA A3000](#), normal type.
- .2 Mix mortar 1 part by volume of cement to two parts of clean, sharp sand mixed dry.
 - .1 Add only sufficient water after mixing to give optimum consistency for placement.
 - .2 Do not use additives.

2.4 PIPE INSULATION

- .1 Water utility distribution piping is to be insulated using a factory applied, rigid foam material with specifications as follows:

Density	35.2 kg/m ³ minimum ASTM D1622
Closed cell content	90 % minimum ASTM D2856
Water Absorption	4.0 % by Volume ASTM D2842-69
Thermal Conductivity	0.023 W/m @ 22 degrees Celsius ASTM C518
System Compressive Strength	Modified ASTM D1621 with 50 mil Jacket. Approximately 414 to 522 kPa, varies with pipe diameter
Thickness	Minimum 50 mm

- .2 Insulated water utility distribution piping shall have a jacket using high-density polyethylene carbon black, factory applied by continuous extrusion or approved tape-wrap method, specified as follows:

Tape Jacket Material	Polyethylene UV inhibited, formulated for superior cold weather properties (to -45 degrees Celsius)
Sealant	Butyl rubber and resin
Tensile Strength	21 MPa minimum (ASTM D1000) 8.93 kg/cm width
Thickness	1.14 mm minimum for extruded polyethylene or 2 cross wraps for a minimum of 1.27 mm for tape-wrapped polyethylene application.

- .3 The pipe is to be located at the center of the insulation material. An allowable tolerance on this is as follows:
- .1 Total diameter of insulation pipe structure is in no instance to be less than the pipe diameter plus 100 mm.
 - .2 The minimum thickness of insulation at any location of the pipe is to be 50 mm.
- .4 The Contractor is to provide suitable tape and is to tape-wrap all locations where such test is performed. Materials, which do not comply with the specification, will be rejected.
- .5 The Consultant is to reserve the right to have representatives present at the installation applicators plant during insulation application. The Contractor is to provide a schedule to the Consultant indicating when the application will take place.
- .6 The pipe joints and fittings are to be insulated with a minimum 50 mm polyethylene half shell or where necessary use approved field insulation kits. Protect insulation with polyethylene heat-shrink sleeve or a triple overlapping wrap of suitable heat-shrinking tape.
- .7 Joints on services shall not be taped. Contractor to coat the exposed insulation at the end of the pie with tar. When compression couplings are used for connection, one end of the half-shell is to be taped to the pipe. The other end of the half shell shall be coated with tar and left untaped.
- .8 Remove insulation from pipe where pipes connect to manholes. Any exposed pipe outside of the manhole is to be reinsulated.
- .9 Styrofoam board insulation is to be installed as/if demonstrated on drawings. Insulation is to be extruded polystyrene with a minimum compressive strength of 35 psi or better. Install using interlocking pieces or overlap sheets 50 mm. Styrofoam board insulation is not a substitute for factory applied insulation or half shells as described above.

2.5 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
- .1 Bedding Sand as indicated and to gradations and compaction specified in Section 31 23 33.01 - Excavating, Trenching and Backfilling.

- .2 Concrete mixes and materials required for bedding cradles, encasement, supports, thrust blocks: to Section 03 30 00 - Cast-in-Place Concrete.

2.6 BACKFILL MATERIAL

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 80 mm Pit Run Gravel and 20 mm Basecourse Gravel to gradations as indicated and to gradations and compaction specified in Section 32 11 23 - Aggregate Base Courses and Section 31 23 33.01 - Excavating, Trenching and Backfilling.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for sewer pipe installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Consultant.
 - .2 Inform Consultant of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 PREPARATION

- .1 Clean pipes and fittings of debris and water before installation, and remove defective materials from site to approval of Consultant.
- .2 Clean and dry pipes and fittings before installation.
- .3 Obtain Consultant 's approval of pipes and fittings before installation.

3.3 TRENCHING

- .1 Do trenching Work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Protect trench from contents of sewer or sewer connection.
- .3 Trench alignment and depth require approval of Consultant before placing bedding material and pipe.

3.4 CONCRETE BEDDING AND ENCASEMENT

- .1 Do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
 - .1 Place concrete to details as indicated.
- .2 Position pipe on concrete blocks to facilitate placing of concrete.
 - .1 When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.
- .3 Do not backfill over concrete within 24 hours after placing.

3.5 GRANULAR BEDDING

- .1 Place bedding in unfrozen condition.

- .2 Place granular bedding materials in uniform layer not exceeding 150mm compacted thickness to depth as indicated.
- .3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.
 - .1 Do not use blocks when bedding pipe.
- .4 Shape transverse depressions as required to suit joints.
- .5 Compact each layer full width of bed in accordance with compaction requirements in Section 31 23 33.02 - Excavating, Trenching and Backfilling.
- .6 Fill excavation below bottom of specified bedding adjacent to manholes or structures with compacted bedding material.

3.6 INSTALLATION

- .1 Lay and join pipes to: [ASTM C12](#).
- .2 Lay and join pipes in accordance with manufacturer's recommendations and to approval of Consultant.
- .3 Handle pipe using methods approved by Consultant.
 - .1 Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
- .4 Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length. Tolerances: 2 mm.
- .5 Begin laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .6 Joint deflection permitted within limits recommended by pipe manufacturer.
- .7 Water to flow through pipe during construction, only as permitted by Consultant.
- .8 Whenever Work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .9 Install plastic pipe and fittings in accordance with [CSA B182.11](#).
- .10 Pipe jointing:
 - .1 Install gaskets in accordance with manufacturer's written recommendations.
 - .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
 - .3 Align pipes before joining.
 - .4 Maintain pipe joints free from mud, silt, gravel and foreign material.
 - .5 Avoid displacing gasket or contaminating with dirt or foreign material. Gaskets so disturbed to be removed, cleaned and lubricated and replaced before joining is attempted.
 - .6 Complete each joint before laying next length of pipe.
 - .7 Minimize joint deflection after joint has been made to avoid joint damage.
 - .8 At rigid structures, install pipe joints not more than 1.2m from side of structure.
 - .9 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.

- .11 When stoppage of Work occurs, block pipes as directed by Consultant to prevent creep during down time.
- .12 Plug lifting holes with pre-fabricated plugs approved by Consultant, set in shrinkage compensating grout.
- .13 Cut pipes as required for special inserts, fittings or closure pieces as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .14 Make watertight connections to manholes.
 - .1 Use shrinkage compensating grout when suitable gaskets are not available.
- .15 Use prefabricated saddles or site connections approved by Consultant, for connecting pipes to existing sewer pipes.
 - .1 Joints to be structurally sound and watertight.

3.7 PIPE SURROUND

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Consultant has inspected pipe joints, surround and cover pipes as indicated.
 - .1 Leave joints and fittings exposed until site testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 150mm compacted thickness as indicated.
 - .1 Do not dump material within 1m of pipe.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer full width of bed in accordance with compaction requirements in Section 31 23 33.02 - Excavating, Trenching and Backfilling.
- .6 When site test results are acceptable to Consultant, place surround material at pipe joints.

3.8 BACKFILL

- .1 Place backfill material in unfrozen condition.
- .2 Place backfill material, above pipe surround in uniform layers not exceeding 150mm compacted thickness up to grades as indicated.
- .3 Compact each layer full width of bed in accordance with compaction requirements in Section 31 23 33.02 - Excavating, Trenching and Backfilling.
- .4 Place unshrinkable fill in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.9 UNDERCROSSING

- .1 Excavate working pit to dimensions indicated, outside right-of-way to be crossed.
- .2 Excavate working pit to minimum of 0.5 m below lowest invert of crossing pipes.
- .3 Dewater excavation.
- .4 Dewater area of undercrossing.

- .5 Provide shop drawings showing proposed method of installation for sanitary sewer in undercrossing.
- .6 Couplings of sanitary sewer pipe: not to rest on levelling pad when sanitary sewer pipe is in position.
- .7 Place 20MPa concrete cradle around sanitary sewer pipe after it is positioned.
 - .1 Cradle to be minimum of 225mm and maximum of 300mm above levelling pad.
- .8 Pressure grout remaining void with grout consisting of 1 part Portland cement and 2 parts clean washed sand with only sufficient amount of water added to allow placement.
 - .1 Do not install pressure grout until sanitary sewer pipe is secure against flotation.
 - .2 Do not use additives.
- .9 Do site testing before placing concrete cradle and grouting.

3.10 SERVICE CONNECTIONS

- .1 Install pipe to [CSA B182.11](#) and manufacturer's instructions and specifications.
- .2 Maintain grade for 100 to 250mm diameter sewers at 1 vertical to 50 horizontal unless directed otherwise by Consultant.
- .3 Service connections to main sewer: Wye.
 - .1 Do not use break-in and mortar patch-type joints.
- .4 Service connection pipe: Not to extend into interior of main sewer.
- .5 Make up required horizontal and vertical bends from 45 degrees bends or less, separated by straight section of pipe with minimum length of 4 pipe diameters.
 - .1 Use long sweep bends where applicable.
- .6 Plug service laterals with water tight caps or plugs as approved by Consultant.
- .7 Place location marker at ends of plugged or capped unconnected sewer lines.
 - .1 Each marker: 38 x 89mm stake extending from pipe end at pipe level to 0.6m above grade.
 - .2 Paint exposed portion of stake red with designation SAN SWR LINE in black.

3.11 SITE TESTING

- .1 Repair or replace pipe, pipe joint or bedding found defective.
- .2 When directed by Consultant, draw tapered wooden plug with diameter of 50mm less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction.
- .3 Remove foreign material from sewers and related appurtenances by flushing with water.
- .4 Perform infiltration and exfiltration testing as soon as practicable after jointing and bedding are complete, and service connections have been installed.
- .5 Do infiltration and exfiltration test to [ASTM C828](#).
- .6 Do infiltration and exfiltration testing as specified herein and as directed by Consultant.
 - .1 Perform tests in presence of Consultant.
 - .2 Notify Consultant 24 hours minimum in advance of proposed tests.
- .7 Carry out tests on each section of sewer between successive manholes including service connections.

-
- .8 Install watertight bulkheads in suitable manner to isolate test section from rest of pipeline.
 - .9 Exfiltration test:
 - .1 Fill test section with water to displace air in line. Maintain under nominal head for 24 hours to ensure absorption in pipe wall is complete before test measurements are begun.
 - .2 Immediately before test period, add water to pipeline until there is head of 1m over interior crown of pipe measured at highest point of test section or water in manhole is 1m above static ground water level, whichever is greater.
 - .3 Duration of exfiltration test: 2 hours.
 - .4 Water loss at end of test period: not to exceed maximum allowable exfiltration over any section of pipe between manholes.
 - .10 Infiltration test:
 - .1 Conduct infiltration test in lieu of exfiltration test where static ground water level is 750mm or more above top of pipe measured at highest point in line to be used.
 - .2 Do not interpolate a head greater than 750mm to obtain an increase in allowable infiltration rate.
 - .3 Install watertight plug at upstream end of pipeline test section.
 - .4 Discontinue pumping operations for at least 3 days before test measurements are to begin and during this time, keep thoroughly wet at least one third of pipe invert perimeter.
 - .5 Prevent damage to pipe and bedding material due to flotation and erosion.
 - .6 Place 90 degrees V-notch weir, or other measuring device approved by Consultant in invert of sewer at each manhole.
 - .7 Measure rate of flow over minimum of 1 hour, with recorded flows for each 5 min interval.
 - .11 Infiltration and exfiltration: Not to exceed the following limits in L per hour per 100m of pipe, including service connections.
 - .1

Nominal Pipe diameter in mm	Plastic pipe	Concrete or Vitrified Clay pipe
100	3.88	25.5
125	4.62	30.0
150	5.51	34.0
200	7.45	41.5
250	9.39	49.5
300	11.33	56.5
350	13.27	63.5
400	14.91	70.0
450	16.84	76.0
500	18.78	81.5
550	20.72	87.0
600	22.80	92.5
700	26.53	102.0
800	30.11	110.5
900	33.69	118.0
1000	37.56	124.5
1100	41.29	130.0
1200	45.01	135.0
Values shown in columns 2 and 3 are in litres per hour per 100 metres of pipe.		

- .12 Leakage: Not to exceed the following limits in litres per hour per mm of diameter per 100 m of sewer including service connections:
- .1 Exfiltration, based on 600mm head: 0.175L
 - .2 Infiltration: 0.150L
- .13 Repair and retest sewer line as required, until test results are within limits specified.
- .14 Repair visible leaks regardless of test results.
- .15 Television and photographic inspections:
- .1 Carry out inspection of installed sewers by video camera, digital camera or by other related means.
 - .2 Provide means of access to permit Consultant to do inspections.
 - .3 Payment for inspection services in accordance with Measurement and Payment in PART 1.
 - .4 Payment for inspection services included as part of installation of sanitary sewer and will not be paid for separately.

3.12 CLEANING

- .1 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment.
- .2 Waste Management: Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 30 00 - Cast-in-Place Concrete
- .2 Section 31 05 16 - Aggregate Materials
- .3 Section 31 23 33.01 - Excavating, Trenching and Backfilling

1.2 REFERENCE STANDARDS

- .1 Department of Justice Canada (Jus)
 - .1 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations.
- .2 ASTM International (ASTM)
 - .1 [ASTM C12-09](#), Standard Practice for Installing Vitrified Clay Pipe Lines.
 - .2 [ASTM C14M-07](#), Standard Specification for Concrete Sewer, Storm Drain and Culvert Pipe (Metric).
 - .3 [ASTM C76M-10a](#), Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe (Metric).
 - .4 [ASTM C117-04](#), Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .5 [ASTM C136-06](#), Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .6 [ASTM D3212-21](#), Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 - .7 [ASTM D698-07e1](#), Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³(600 kN-m/m³)).
 - .8 [ASTM F2764-19](#), Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications.
 - .9 [ASTM F477-14\(2021\)](#), Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
 - .10 [ASTM D1056-07](#), Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
 - .11 [ASTM D3034-08](#), Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - .12 [ASTM F405-05](#), Standard Specification for Corrugated Polyethylene (PE) Tubing and Fittings.
 - .13 [ASTM F794-03\(2009\)](#), Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- .3 Canadian General Standards Board (CGSB)
 - .1 [CAN/CGSB-8.1-M89](#), Sieves, Testing, Woven Wire, Inch Series.
 - .2 [CAN/CGSB-8.2-M88](#), Sieves, Testing, Woven Wire, Metric.
 - .3 [CAN/CGSB-34.9-94](#), Asbestos-Cement Sewer Pipe.
- .4 CSA Group (CSA)

- .1 [CAN/CSA-B1800-06](#), Thermoplastic Non-pressure Pipe Compendium - B1800 Series.

1.3 SCHEDULING

- .1 Schedule Work to minimize interruptions to existing services and to maintain existing flow during construction.
- .2 Submit schedule of expected interruptions for approval and adhere to approved schedule.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for pipes, and backfill and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Shop drawings to indicate proposed method for installing carrier pipe for undercrossings.
 - .2 Submit drawings stamped and signed by professional engineer registered or licensed in Yukon Territory, Canada.
- .4 Samples:
 - .1 Inform Consultant at least 4 weeks prior to beginning Work, of proposed source of bedding materials and provide access for sampling.
- .5 Certification to be marked on pipe.
- .6 Test and Evaluation Reports: submit manufacturer's test data and certification at least 2 weeks prior to beginning Work.
- .7 Manufacturer's Instructions: submit to Consultant 1 copy of manufacturer's installation instructions.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect pipes from damage.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 PLASTIC PIPE

- .1 Type PSM Poly Vinyl Chloride (PVC): to [ASTM D3034](#).
 - .1 Standard Dimensional Ratio (SDR): 35.
 - .2 Locked-in gasket and integral bell system.
 - .3 Nominal lengths: 6 m.

2.2 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Bedding Sand as indicated and to gradations and compaction specified in Section 31 23 33.01 - Excavating, Trenching and Backfilling.
 - .2 Concrete mixes and materials required for bedding cradles, encasement, supports, thrust blocks: to Section 03 30 00 - Cast-in-Place Concrete.

2.3 PIPE INSULATION

- .1 Water utility distribution piping is to be insulated using a factory applied, rigid foam material with specifications as follows:

Density	35.2 kg/m ³ minimum ASTM D1622
Closed cell content	90 % minimum ASTM D2856
Water Absorption	4.0 % by Volume ASTM D2842-69
Thermal Conductivity	0.023 W/m @ 22 degrees Celsius ASTM C518
System Compressive Strength	Modified ASTM D1621 with 50 mil Jacket. Approximately 414 to 522 kPa, varies with pipe diameter
Thickness	Minimum 50 mm

- .2 Insulated water utility distribution piping shall have a jacket using high-density polyethylene carbon black, factory applied by continuous extrusion or approved tape-wrap method, specified as follows:

Tape Jacket Material	Polyethylene UV inhibited, formulated for superior cold weather properties (to -45 degrees Celsius)
Sealant	Butyl rubber and resin
Tensile Strength	21 MPa minimum (ASTM D1000) 8.93 kg/cm width
Thickness	1.14 mm minimum for extruded polyethylene or 2 cross wraps for a minimum of 1.27 mm for tape-wrapped polyethylene application.

- .3 The pipe is to be located at the center of the insulation material. An allowable tolerance on this is as follows:
 - .1 Total diameter of insulation pipe structure is in no instance to be less than the pipe diameter plus 100 mm.
 - .2 The minimum thickness of insulation at any location of the pipe is to be 50 mm.
- .4 The Contractor is to provide suitable tape and is to tape-wrap all locations where such test is performed. Materials, which do not comply with the specification, will be rejected.
- .5 The Consultant is to reserve the right to have representatives present at the installation applicators plant during insulation application. The Contractor is to provide a schedule to the Consultant indicating when the application will take place.

- .6 The pipe joints and fittings are to be insulated with a minimum 50 mm polyethylene half shell or where necessary use approved field insulation kits. Protect insulation with polyethylene heat-shrink sleeve or a triple overlapping wrap of suitable heat-shrinking tape.
- .7 Joints on services shall not be taped. Contractor to coat the exposed insulation at the end of the pipe with tar. When compression couplings are used for connection, one end of the half-shell is to be taped to the pipe. The other end of the half shell shall be coated with tar and left untaped.
- .8 Remove insulation from pipe where pipes connect to manholes. Any exposed pipe outside of the manhole is to be reinsulated.
- .9 Styrofoam board insulation is to be installed as/if demonstrated on drawings. Insulation is to be extruded polystyrene with a minimum compressive strength of 35 psi or better. Install using interlocking pieces or overlap sheets 50 mm. Styrofoam board insulation is not a substitute for factory applied insulation or half shells as described above.

2.4 BACKFILL MATERIAL

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 80 mm Pit Run Gravel and 20 mm Basecourse Gravel to gradations as indicated and to gradations and compaction specified in Section 32 11 23 - Aggregate Base Courses and Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.5 JOINT MORTAR

- .1 Portland cement: to [CAN/CSA-A3000](#), normal type.
- .2 Mortar: one part Portland cement to two parts clean sharp sand mixed with minimum amount of water to obtain optimum consistency for use intended. Do not use additives.

Part 3 Execution

3.1 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control plan, specific to site, that complies with requirements of authorities having jurisdiction.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .2 Clean pipes and fittings of debris and water before installation, and remove defective materials from site to approval of Consultant.

3.2 TRENCHING

- .1 Do trenching Work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Protect trench from contents of sewer.

- .3 Trench alignment and depth to approval of Consultant prior to placing bedding material and pipe.

3.3 CONCRETE BEDDING AND ENCASEMENT

- .1 Do concrete Work in accordance with Section 03 30 00.50 - Cast-in-Place Concrete - Civil. Place concrete to details as indicated.
- .2 Position pipe on concrete blocks to facilitate placing of concrete.
 - .1 When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.
- .3 Backfill over concrete after 24 hours from placing.

3.4 GRANULAR BEDDING

- .1 Place bedding in unfrozen condition.
- .2 Place granular bedding materials in uniform layer not exceeding 150mm compacted thickness to depth as indicated.
- .3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.
 - .1 Do not use blocks when bedding pipe.
- .4 Shape transverse depressions as required to suit joints.
- .5 Compact each layer full width of bed in accordance with compaction requirements in Section 31 23 33.02 - Excavating, Trenching and Backfilling.
- .6 Fill excavation below bottom of specified bedding adjacent to manholes or structures with compacted bedding material.

3.5 INSTALLATION

- .1 Lay and join pipes to: [ASTM C12](#).
- .2 Lay and join pipe in accordance with manufacturer's recommendations and to approval of Consultant.
- .3 Handle pipe using methods approved by Consultant.
 - .1 Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
- .4 Lay pipes on prepared bed, true to line and grade with pipe inverts smooth and free of sags or high points.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .5 Begin laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .6 Lay corrugated steel pipe:
 - .1 With outside circumferential laps facing upgrade and longitudinal laps or seams at side or quarter points.
 - .2 With longitudinal centre line of paved invert coinciding with flow line.
- .7 Joint deflection permitted within limits recommended by pipe manufacturer.
- .8 Water to flow through pipes during construction only as permitted by Consultant.

-
- .9 Whenever Work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
 - .10 Install plastic pipe and fittings in accordance with [CAN/CSA-B1800](#).
 - .11 Joints:
 - .1 Corrugated steel pipe:
 - .1 Install gaskets as indicated.
 - .2 Match corrugations or indentations of coupler band with pipe sections before tightening.
 - .3 Tap coupler firmly while tightening, to take up slack and ensure snug fit.
 - .4 Ensure bolts are inserted and tightened.
 - .2 Concrete, clay and asbestos cement pipe:
 - .1 Install gaskets as recommended by manufacturer.
 - .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
 - .3 Align pipes before joining.
 - .4 Maintain pipe joints free from mud, silt, gravel and other foreign material.
 - .5 Avoid displacing gasket or contaminating with dirt or other foreign material. Remove disturbed or dirty gaskets; clean, lubricate and replace before joining is attempted.
 - .6 Complete each joint before laying next length of pipe.
 - .7 Minimize joint deflection after joint has been made to avoid joint damage.
 - .8 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
 - .9 Mortared joints:
 - .1 Pipe exterior: for bell and spigot pipe, use mortar to seal outside of joints. Press and bed mortar into place.
 - .1 Allow mortar to set minimum of 1 hour before backfilling.
 - .12 When any stoppage of Work occurs, restrain pipes as directed by Consultant, to prevent "creep" during down time.
 - .13 Plug lifting holes with Consultant approved prefabricated plugs, set in shrinkage compensating grout.
 - .14 Cut pipes as required for special inserts, fittings or closure pieces, as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
 - .15 Make watertight connections to manholes and catch basins.
 - .1 Use shrinkage compensating grout when suitable gaskets are not available.
 - .16 Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes.
 - .1 Joint to be structurally sound and watertight.
 - .17 Temporarily plug open upstream ends of pipes with removable watertight concrete, steel or plastic bulkheads.
-

3.6 PIPE SURROUND

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Consultant has inspected pipe joints, surround and cover pipes as indicated.
 - .1 Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
 - .1 Do not dump material within 1 m of pipe.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer from pipe invert to underside of backfill for the full width of the bed in accordance with compaction requirements in Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .6 When field test results are acceptable to Consultant, place surround material at pipe joints.

3.7 BACKFILL

- .1 Place backfill material, above pipe surround, in uniform layers not exceeding 150mm compacted thickness up to grades as indicated.
- .2 Do not place backfill in frozen condition.
- .3 Compact each layer for the full width of the bed in accordance with compaction requirements in Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.8 UNDERCROSSING

- .1 Excavate working pit to dimensions indicated, outside right-of-way to be crossed.
- .2 Excavate working pit to minimum of 0.5 m below lowest invert of encasing pipe.
- .3 Dewater excavation.
- .4 Dewater area of undercrossing.
- .5 Provide shop drawings showing proposed method of installation for storm sewer pipe.
- .6 Couplings of storm sewer pipe: not to rest on levelling pad when carrier pipe is in position.
- .7 Place 20 MPa concrete cradle around storm sewer pipe after it is positioned.
 - .1 Cradle to be minimum of 225 mm and maximum of 300 mm above levelling pad.
- .8 Pressure grout remaining void with grout consisting of one part Portland cement and two parts clean washed sand with only sufficient amount of water added to allow placement.
 - .1 Install pressure grout after storm sewer pipe is secure against flotation.
 - .2 Do not use additives.
- .9 Do field testing before placing concrete cradle and grouting.

3.9 FIELD TESTS AND INSPECTIONS

- .1 Repair or replace pipe, pipe joint or bedding found defective.

- .2 Draw tapered wooden plug with diameter of 50 mm less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction directed by Consultant.
- .3 Remove foreign material from sewers and related appurtenances by flushing with water.
- .4 Television and photographic inspections:
 - .1 Carry out inspection of installed sewers by television camera, photographic camera or by other related means.
 - .2 Provide means of access to permit Consultant to do inspections.

3.10 CLEANING

- .1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 00 10 - General Requirements.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 00 10 - General Requirements.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Section 26 05 00 - Common Work Results to apply to this section.
- .3 Section 26 05 28 - Grounding and Bonding
- .4 Division 03 - Concrete.
- .5 Division 31 - Excavation, Trenching and Backfilling.
- .6 Light pole bases: refer to detail.

1.2 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Division 01 Sustainable Requirements: Construction
- .2 Do verification requirements in accordance with Division 01 Sustainable Requirements: Contractor's Verification.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 - Construction/Demolition Waste Management and Disposal and with the Waste Reduction Workplan.
- .2 Avoid using landfill waste disposal procedures when recycling facilities are available.
- .3 Place materials defined as hazardous or toxic waste in designated containers.

1.4 SCOPE OF WORK

- .1 Provide a complete system for the distribution of electric power and communication service from the point of supply to the utilization equipment.
- .2 Provide electrical services to site and landscape lighting.
- .3 Provide electrical services to miscellaneous equipment as detailed.
- .4 Provide pull boxes and all associated requirements.
- .5 Provide underground ducts, protection and encasements as indicated on drawings.
- .6 Conduit for site lighting and receptacles is drawn diagrammatically. Conduit to be routed in an orderly manner and where practical, shall maintain a minimum of 3m clear of existing vegetation or proposed vegetation as indicated on Landscape Drawings.
- .7 Underground conduit and duct routing location to be clearly documented on the "Record Drawings" with set back dimensions from key fixed points.

Part 2 Products

2.1 PVC DUCTS - UNDERGROUND

- .1 Main power and communication ducting to CSA C22.2 No. 211.1 M1984 (R1999)], Rigid type DB2/ES2 PVC Conduit. Direct burial with cable marker above.
- .2 Concrete encased ducting where indicated to CSA C22.2 No. 211.1 M1984 (R1999) Rigid types EBI PVC Conduit.
- .3 FRE ducting to be CSA C22.2 No. 211.3- 96(R2000)], Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
- .4 Sub-circuit underground ducting up to 53mm [2"] in diameter for sub feeds, parking lot lighting, etc.) to be rigid heavy duty schedule 40 PVC ducting equal to *Scepter* bedded in sand with cable marker above. Minimum depth of burial to be in accordance with code or as indicated.

2.2 PVC DUCT FITTINGS

- .1 Rigid PVC solvent welded type couplings, bell end fittings, plugs, caps, adapters to be same material as duct to provide a complete installation.
- .2 All bell ends to incorporate tie-seal gasket and retainer ring. Provide bell ends at all duct terminations unless otherwise indicated.
- .3 Expansion joints as required.
- .4 Rigid PVC 5 degree angle couplings as required.
- .5 Long radius 45⁰ bends shall be used where major bends are required.

2.3 CABLE PULLING EQUIPMENT

- .1 6 mm stranded nylon pull rope tensile strength 5 kN.

2.4 CABLE MARKERS

- .1 Yellow PVC, sized to suit full width of trench marked "DANGER - BURIED ELECTRICAL SERVICE"

2.5 DUCT SPACERS

- .1 Provide approved PVC duct spacers to maintain horizontal and vertical separation.

2.6 SITE LIGHTING

- .1 Refer to light fixture schedule.
- .2 Provide all anchor bolts, poles and base plates.

2.7 UTILITY PULL BOXES

- .1 Provide concrete service pull boxes to utility standards as indicated and/or required. Provide all required material.

2.8 CAST IN PLACE AN PRECAST CONCRETE MANHOLES/PULL BOXES

- .1 Provide cast in place or precast concrete manholes and pull boxes as indicated in the drawings.

- .2 Precast concrete manholes and auxiliary sections fabricated in steel forms.
- .3 All on-site manholes, pull boxes and service vault covers shall provide security protection for site services including lockable covers.
- .4 Manholes and pull boxes shall be field sized to meet the minimum requirements as per CEC and the minimum requirements for each duct bank.
- .5 Aggregates: to CSA A23.1/A23.2.
- .6 Portland cement: to CAN/CSA-A3000-A5
- .7 Steel welded wire fabric mesh reinforcing: to CSA G30.
- .8 Pulling inserts and bolts for racks integrally cast in concrete.
- .9 Size: Size as indicated in the drawings.
- .10 Acceptable Manufacturer (Precast): A.E Concrete or other pre-approved manufacturer.

2.9 PULLBOXES FOR SUB DISTRIBUTION

- .1 Provide 300mm x 500mm x 500mm deep sub distribution precast concrete junction boxes for site sub distribution and lighting as manufactured by "A E Concrete Precast Products Ltd.", Surrey, B.C., or approved equal, complete with galvanized chequer plate covers.
- .2 All junction boxes shall have open bottoms for the distribution wiring raceways to enter from below. Knockouts in the walls shall provide access for conduits to enter from the side.

2.10 CONCRETE ENCASEMENTS

- .1 Concrete mixture to use screened 13 mm maximum water washed gravel. Concrete shall have 176 kg/cm² (2500 psi) compressive strength at twenty-eight (28) days. Bends and offsets shall be minimum 900 mm radius. Suitable factory made spacers, of cast concrete or plastic, shall be installed at 1200 mm maximum intervals, to maintain a clear spacing as shown between ducts for the concrete. Stain top of concrete duct by mixing red staining agents into top 25mm of the concrete.
- .2 Ducts and spacers shall be securely braced to prevent duct from floating when concrete is placed.
- .3 Care shall be taken to ensure that joints are watertight and concrete is vibrated between and under ducts. Water leaks through the duct bank shall be treated and duct bank repaired in a satisfactory manner.
- .4 Ducts shall be terminated with bell-end fittings.
- .5 Provide drainage openings at lowest point of duct run and tie into site drainage system.

Part 3 Execution

3.1 DUCT AND CONDUIT INSTALLATION

- .1 Install duct as indicated and to manufacturer's instructions.
- .2 Clean inside of ducts before laying.

- .3 Cut, rim and taper end of ducts in field to manufacturer's recommendations, so that duct ends are fully equal to factory made ends.
- .4 Ensure full, even support every 1.2 m [4'] throughout duct length.
- .5 Slope ducts to indicated inverts with 1 to 200 minimum slope.
- .6 Provide drainage from lowest point of duct run and drain all ducts into the site drainage system. Unless otherwise indicated ductbanks shall slope to pull pits and service boxes.
- .7 Provide duct drains for utility ducts as required by the Utility standards.
- .8 During construction, cap ends of ducts to prevent entrance of foreign materials.
- .9 Ductbanks to sit on undisturbed soil on a bed of sand. Where backfill under ductbank is required, thoroughly compacted pit run gravel and sand to be installed in 200mm [8"] lifts.
- .10 Make transpositions, offsets and changes in direction using 5° bend sections, do not exceed a total of 20° with duct offset.
- .11 Provide concrete reinforcement to any bends or off-sets for underground ductwork systems where direct burial of ducts are permitted.
- .12 In no case shall the concrete envelope of duct banks be laid within 150mm [6"] of any water, sewer or gas distribution pipes unless approved by Consultant.
- .13 A 300 mm [12"] minimum separation of well tamped material, must be maintained between different direct buried services.
- .14 Care shall be taken not to alter or remove, without consent of the owner or authority, any structure crossing or running parallel to the excavation.
- .15 Pull through each duct a mandrel not less than 300 mm [12"] long and of a diameter 6 mm [.25"] less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .16 In each duct install pull rope continuous throughout each duct run with 3m [10'] spare rope at each end.

3.2 ELECTRICAL SERVICES

- .1 The electrical and telephone services will be underground duct and cables to the Electrical Room. Service voltage will be as noted on plans.
- .2 The Electrical Trade will be responsible for the co-ordination and marking out of pullboxes, trenching, and concrete encasements. Refer to Architectural Specification for scope of General Contractor's work. The Electrical Trade to be responsible for the installation, bedding and protection of the electrical ducts.

3.3 SITE & LANDSCAPE LIGHTING

- .1 Install all site lighting and pull boxes. Coordinate concrete base installation. Mark out all trenches.

- .2 Precast concrete sub distribution junction boxes shall be installed flush with finished grade and shall be set on a 50 mm bed of coarse gravel.

3.4 MARKING OUT OF SERVICE

- .1 The electrical Trade will be responsible for the coordination and marking out of pullboxes, trenching and concrete encasements. Refer to Division 01 specification for Scope of General Contractor's Work. The Electrical Trade to be responsible for the installation, bedding and protection of the electrical ducts.

3.5 EXISTING AND OTHER SERVICES

- .1 Protect all existing and other services encountered.
- .2 Before starting the trenching, locate and expose any utility lines crossing the duct route and ensure that these lines are not damaged in the course of trenching operations. The Contractor is responsible for all damage caused by negligence.
- .3 Provide temporary bridges for the passage of traffic over any trenches where necessary. Provide temporary crossings at walkways in order to maintain all existing accessways and provide barriers, signs and lights as required.

3.6 EXCAVATION, CONCRETE AND BACKFILLING

- .1 Coordinate all excavation, sand levelling and bedding ready for the electrical installation. Level all trenches for underground conduit and duct lines with a 75 mm layer of screened sand.
- .2 Elevations of ductbank assemblies shall be such that there will be a minimum of 900mm cover material on top of ductbank unless otherwise detailed. Base tender price to include all costs associated with ductbank elevation variances from 900mm to 4m below grade.
- .3 Conduit not encased in concrete to be bedded in screened sand and covered by a second 150 mm layer of compacted screened sand. Provide a warning tape above the buried sections of conduit or cable.
- .4 Supervise all backfilling of electrical services and underground conduit runs.
- .5 Coordinate all concrete work directly related to the electrical installation including housekeeping bases, curbs, conduit encasement is specified in Division 03 of specifications.
- .6 Concrete encased ductbanks to be installed by monolithic pour method and to be supported on plastic duct spacers to provide a minimum of 75mm concrete cover between ducts and soil and to provide a minimum of 50mm concrete between ducts in the assembly. All ducts to be securely anchored down to prevent floating or displacement when concrete is poured. Stagger joints in adjacent layers not less than 300mm. Spacers to be located on 1500mm spacing maximum and 300mm for ductbank ends. Forms (wood) shall be used for ductbank forming.
- .7 Supervise pouring of concrete to ensure that the integrity of the systems is maintained. Concrete to be placed by chute or trunks and to be thoroughly rodded to flow between and under all ducts.

END OF SECTION



Polaris Project - CD Report Submission



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March 11, 2024

POLARIS PROJECT - CD REPORT SUBMISSION

This document entitled Polaris Project - CD Report Submission was prepared by Stantec Consulting Ltd. ("Stantec") for the account of Yukon University (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

This report summarizes the results of energy simulations based on information available to Stantec at the time of preparation, including information from third parties about construction materials, equipment, proposed operation procedures, and projected usage. Simulations are not exact predictions of actual energy use or actual operating costs. Actual energy use and cost will differ from these simulations due to a number of reasons, including but not limited to variations in building construction, operation and maintenance, occupancy, operation schedules, equipment efficiencies, as well as differences between actual weather and the typical meteorological year represented in the climate data file. The results of these simulations cannot be used to size equipment.

Some assumptions have been made for parameters of the operation or performance of equipment and materials where data was not available. The use of these values and parameters shall in no way imply endorsement of a specific product or manufacturer

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Executive Summary

This report presents the findings of the energy simulation study performed for the Polaris Project. The proposed building is located at Yukon University in Whitehorse, YK. The building has 1 storey and approximately 2,842 m² of conditioned floor area. For the purposes of modelling the building is categorized as a laboratory building.

A whole-building energy model was created based on the Issued for 90% Detailed Design (DD) submission and input from the design team. This project must comply with the CaGBC ZCB standard. The ZCB requires a TEDI score less 57.6 kWh/m² and 25% energy reduction as compared to the National Energy Code for Buildings, 2017. The inputs for the energy model are based on architectural site plans, architectural Revit models, and input from the mechanical and electrical engineering team.

Table 1 demonstrates that the proposed designs achieve high energy savings when compared to the reference NECB 2017 building as well as a low TEDI score and therefore they are projected to comply with the requirements of CaGBC ZCB.

Table 1 Summary of Results for NECB 2017 Compliance

Performance Metric	Target	Performance Result	CaGBC ZCB Compliant
Energy Savings	25%	57.6%	Yes
TEDI	57.6 kWh/m ² *	35.2 kWh/m ²	Yes

* The TEDI target shown is the adjusted target as defined by ZCB due to high ventilation requirements of the laboratory spaces

The model is based on available drawings, specifications and estimations as noted in the Assumptions Summary.



Abbreviations

ACH	Air Change per Hour
AHU	Air Handling Unit
ASHRAE	American Society of Heating, Refrigeration and Air-conditioning
CaGBC	Canadian Green Building Council
COP	Coefficient of Performance
CSA	Canadian Standard Association
DHW	Domestic Hot Water
ECM	Energy Conservation Measure
HVAC	Heating, Ventilation, and Air Conditioning
LED	Light Emitting Diode
LEED	Leadership in Energy and Environment Design
LPD	Lighting Power Density
NECB	National Energy Code for Buildings
OA	Outdoor Air
SHGC	Solar Heat Gain Coefficient
TMY	Typical Meteorological Year
WWR	Window to Wall Ratio
ZCB	Zero Carbon Building



POLARIS PROJECT - CD REPORT SUBMISSION

March 11, 2024

1.0 INTRODUCTION

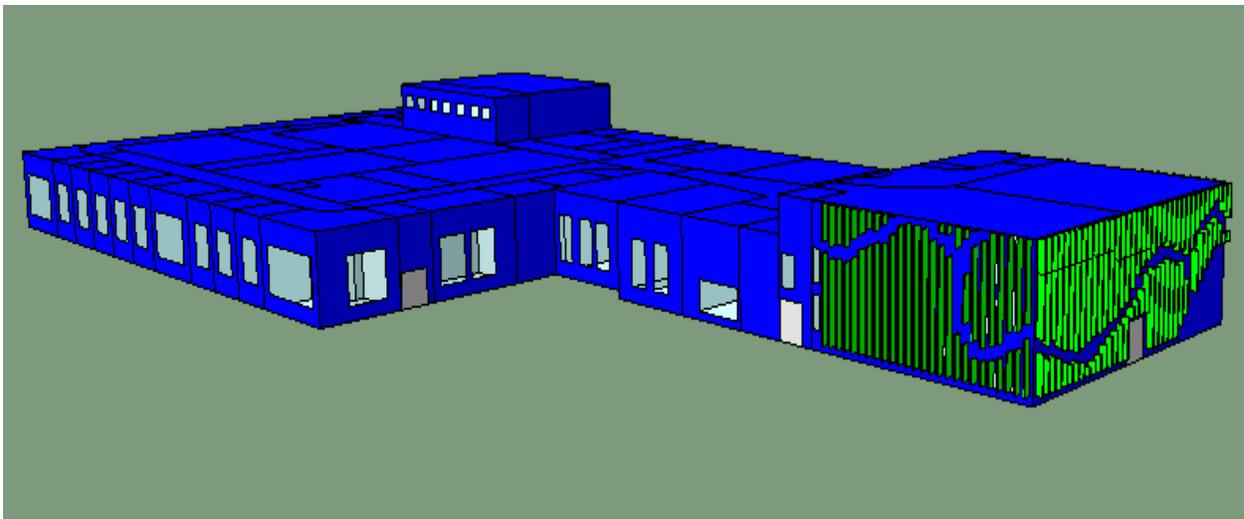
This report presents the findings of the energy simulation study performed for the Polaris Project. This project aims to be Yukon's first zero carbon building as defined by CaGBC Zero Carbon Building Standard. This report summarizes the energy modeling methodology, inputs, assumptions, results, and conclusions.

1.1 PROJECT DESCRIPTION

This report presents the findings of the energy simulation study performed for the Polaris Project. The proposed building is located at Yukon University in Whitehorse, YK. The building has 1 storey and approximately 2,842 m² of conditioned floor area. For the purposes of modelling the building is categorized as a laboratory building.

A whole-building energy model was created based on the 90% DD drawing submission and input from the design team. Figure 1 shows a rendering of the energy model.

Figure 1 IES v2023 Model Rendering



March 11, 2024

1.2 PERFORMANCE TARGETS

1.2.1 Energy Performance Metric Definition

The following metrics are used in this report to estimate the energy performance of the project:

- **Thermal Energy Demand Intensity (TEDI):** TEDI is a measure of the total annual heating demand. As this metric is a measure of the demand, it does not take into account the efficiencies of the mechanical systems. Minimizing TEDI requires a high-performance envelope with minimal thermal breaks, energy recovery on ventilation systems and a well-constructed air-barrier. Focusing on TEDI reduction throughout design will mean less demand on the mechanical systems to keep space temperatures comfortable which translates to reduced operational costs. An added benefit with reducing TEDI is also that the building may increase its passive survivability as it can maintain heat for longer in periods of service outages.
- **Energy Use Intensity (EUI):** This metric is simply the measurement of annual total energy consumption. This is minimized through the operational efficiency of the mechanical equipment once the envelope has been optimized to reduce the TEDI score. Equipment such as high efficiency ground source heat pumps and automated operational systems are utilized to reduce the EUI which will result in reduced operational costs and carbon.

A whole-building compliance energy model is required to demonstrate compliance with CaGBC ZCB. The energy use shall be at least 25% below the National Energy Code for Buildings (NECB 2017) baseline and a TEDI target of 57.6 kWh/m². The TEDI Target shown is the adjusted TEDI as the defined in CaGBC ZCB for spaces with unique ventilation loads (laboratory spaces).

1.3 STUDY LIMITATIONS

The results from this study are used to determine energy performance for compliance purposes. The calculations are not predictions of actual energy use or operating cost of the building after construction. Actual energy use and cost will differ from these calculations due to a number of variables including variations in occupancy and building operation schedules; energy use for equipment not included in the simulation or not covered by the applicable energy code; differences in actual weather and the typical meteorology year represented in the climate data files; and changes in energy costs.

2.0 MODELING METHODOLOGY

2.1 SOFTWARE TOOL

The energy models were created using the IES Virtual Environment (IESVE) building energy modelling program (version 2023). The IESVE program complies with the NECB 2017, Method of Test for the Evaluation of Building Energy Analysis Computer Programs.

- Building Geometry

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- Building Layout
- Window Design
- Type of glazing
- Type of building materials and construction
- Internal lighting types and schedules
- Zone temperature set point and schedules
- Terminal equipment characteristics and performance
- Central system characteristics and performance
- Energy type and cost

2.2 MODELING PROCEDURE

The proposed and reference energy models were generated using IESVE building energy modelling program (version 2023). The proposed model refers to the current design, whereas the reference models are in accordance with NECB 2017. The results of these models were compared to determine the annual energy cost savings achieved by the proposed building.

The reference building is identical to the proposed building in the following aspects:

- Building geometry except external shade
- Air leakage
- Occupancy
- Operating schedules
- Thermostat setpoints
- Receptacle loads

2.3 UNMET LOAD HOURS

Except for unoccupied, unconditioned or transition spaces, the unmet load hours for the proposed and reference building spaces are meeting their respective requirements below for heating and cooling. The requirements for NECB 2017 are:

- The number of hours during which the heating loads for each thermal block are not met shall not exceed 100 hours in a simulated year for both the proposed and reference buildings.
- The number of hours during which the cooling loads for each thermal block of the proposed building are not met shall not differ by more than $\pm 10\%$ from the number of hours in a simulated year that the cooling loads of the reference building are not met.

3.0 INPUTS AND ASSUMPTIONS

This section summarizes the key inputs and assumptions used in the energy models. Attempts have been made to ensure the accuracy of the results in this report, however, variations in building components and assumptions will affect the results. For this reason, the inputs and assumptions presented in this report should be reviewed, and any discrepancies found should be brought to the attention to the Stantec Building Performance team as soon as possible.



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3.1 CLIMATE DATA

The weather file used in the simulations is a Typical Meteorological Year (TMY 2007-2021) file for Whitehorse, Yukon. This is the most representative location for which a weather file is available, based on proximity and similarities in heating degree days. The TMY climate data describes a typical meteorological year and includes hourly values for various parameters including the following:

- Dry bulb temperature
- Dew point temperature
- Relative humidity
- Solar radiation
- Wind speed and direction
- Cloud cover

The weather data does not consider possible changes as a result of climate change. However, the weather file chosen is an average of recent years which are representative of the changing climate of the Yukon.

3.2 Architecture

Reducing TEDI is in large part, the responsibility of the building envelope. Designing a high-performance envelope was critical in achieving a zero-carbon building. Additionally, CaGBC requires carbon offsets in response to the embodied carbon in the envelope and structure of the building. To design a high-performance building with limited thermal bridging as well as reducing the embodied carbon, a timber frame construction using Larsen trusses are employed. Minimum effective performance of R35 for the exterior walls and R55 for the roof are achieved after thermal bridging. High performance fiberglass triple pane frames achieving U-0.14 are used throughout. Airtight building design and achieving passive house levels of infiltration helps reducing TEDI considerably.

3.3 Lighting Design

The lighting power densities have been modelled in accordance with the 90% electrical design drawings. The reference model is based on NECB 2017.

3.4 Mechanical and HVAC

Mechanical zoning is based on the ventilation and controls design as per the mechanical drawings. The proposed building HVAC system consists of:

- DOAS-ERV: High performance energy recovery device with total effectiveness of 90+%. The DOAS will provide OA to the spaces through fan powered terminal boxes equipped with hot and chilled water coils. Occupied spaces will also contain CO₂ sensors to reduce OA when spaces do not need full ASHRAE 62.1 spaces due to reduced occupancy,
- Radiant Panels: Perimeter washroom and storage spaces will be equipped with radiant panels to counter envelope loss,

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- Heating for this building is primarily obtained through a heat recovery loop to the existing energy center boiler plant through a flue gas economizer. Backup electric boilers are used if needed,
- Water-to-water heat pumps from the chilled water loop to hot water loop for heat recovery off of waste heat,
- High efficiency variable speed fume hoods are used in the laboratory buildings to reduce the amount of make-up air required in these spaces.

3.5 NECB 2017 REFERENCE BUILDING

The reference building was built in accordance the NECB 2017 energy standard. The reference building HVAC system includes the NECB 2017 System 3: Single-zone packaged rooftop unit with baseboard heating for the majority of the facility. The reference building has outdoor air rates that are set the same as the proposed design. For rooms that do not need fresh air or and only have heating or cooling, the systems are the same as the proposed design. Similarly, for specialized systems e.g. (fumehood exhaust and make up air) the reference has been modelled identical to the proposed design.

3.6 SUMMARY OF INPUTS AND ASSUMPTIONS

Table 2 summarizes the key simulation inputs for the reference and proposed buildings.

Table 2 Model Input Summary

	Reference Building (NECB 2017)	Proposed Design (Values based on design documents)
	General	
Location	Whitehorse, Yukon	
Simulation Weather File	TMY 2007-2021	
Climate Zone	Climate Zone: 7B, HDD 6580	
Modeling Software	IESVE 2023	
Reference Standard(s)	NECB 2017	
Building floor space	Conditioned Floor Area in the model: 2,842 m ²	
GHG Intensity	Electricity GHG Intensity 120 g CO ₂ eq/kWh	CaGBC ZCB v3



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	Reference Building (NECB 2017)	Proposed Design (Values based on design documents)
Hours of operation	NECB D (M-F, 0600-2300)	
Envelope Performance		
Overall Roof U-value (W/m ² K)	NECB 2017 - CZ 7B Effective RSI-7.22 (R-41/USI-0.138)	R_{eff} 55 (USI 0.102) Includes thermal bridging as per 3.1.1.7.
Ground Floor U-value (W/m ² K)	R _{eff} 7.5 (USI 0.757 for 1.2m)	R_{eff} 20 fully insulated slab
Overall Above-Ground Wall U-value (W/m ² K)	NECB 2017 - CZ 7B Effective RSI-4.76 (R-27/USI-0.21)	R_{eff} 35.8 (USI 0.158) Includes thermal bridging as per 3.1.1.7
Overall Door U-value (W/m ² K) including frame	R _{eff} 3.0 (USI 1.9)	Thermally broken frames, insulated doors R_{eff} 3.91 (USI 1.45)
Overall Glazing U-value including Frame (W/m ² K), and (SHGC)	Effective U-0.33 (USI-1.9) SHGC=same as proposed	Triple Glazed – Thermally broken fibreglass Frame R_{eff} 6.76 (USI 0.84) SHGC 0.40
Fenestration and door area to gross wall area (FDWR)	FDWR = 22.8% for 6580 HDD FDWR = 15.6% for Zero Carbon reference model	15.6 % FDWR
Shading Devices	Not modelled per 8.4.4.3 - 4	Vertical “river” fins
Internal Loads		
Elevator	N/A	
Exterior Lights	Not modelled at this phase	Not modelled at this phase
Infiltration	0.25 L/(s·m ²) @5 Pa of total gross above-ground wall and roof areas Source: NECB 2017 A-8.4.3.3.(3)	For NECB comparison: 0.25 L/s/m ² @ 5 Pa (0.80 L/s/m ² @ 75 Pa) - of total gross above-ground wall and roof areas For ZCB TEDI analysis: Passive house level infiltration

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	Reference Building (NECB 2017)	Proposed Design (Values based on design documents)
		0.087 L/s/m ² @ 5 Pa (0.44 L/s/m ² @ 75 Pa)
Lighting Power Density (LPD) Source: NECB 2017	Space Type	W/m²
	Café	13.1
	Ceremony Room	5.9
	Classrooms / Lecture	6.4
	Corridors	7.1
	Labs	9.0
	Multipurpose Areas	7.2
	Electrical / Mechanical	4.6
	Offices	7.8
	Storage Areas	3.7
Washrooms	5.7	
	Space Type	W/m²
	Café	6.3
	Ceremony Room	12.8
	Classrooms / Lecture	4.4-5.6
	Corridors	13.6
	Labs	9.5-10.6
	Multipurpose Areas	17.6
	Electrical / Mechanical	5.2-7.5
	Offices	9.9
	Storage Areas	5.0
	Washrooms	4.8
Lighting Controls	Mandatory lighting controls as per NECB 2017 Occupancy controls reduction as per absence of occupancies defined in NECB 2017 for space types	
Equipment Load Source: NECB 2017	Space Type	W/m²
	Café	2.5
	Ceremony Room	1
	Classrooms / Lecture	5
	Corridors	0
	Labs	10
	Multipurpose Areas	1
	Electrical / Mechanical	1
	Offices	7.5
	Storage Areas	0
Washrooms	1	
Occupancy (m ² /person) Source: NECB 2017	Space Type	W/m²
	Café	30
	Ceremony Room	5
	Classrooms / Lecture	7.5
	Corridors	100
	Labs	20
	Multipurpose Areas	5
	Electrical / Mechanical	200
	Offices	20
Storage Areas	100	



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	Reference Building (NECB 2017)	Proposed Design (Values based on design documents)
	Washrooms	30
Domestic Hot Water Load	<p>Space Type</p> <p>Café 90</p> <p>Ceremony Room 45</p> <p>Classrooms / Lecture 65</p> <p>Corridors 0</p> <p>Labs 180</p> <p>Multipurpose Areas 45</p> <p>Electrical / Mechanical 0</p> <p>Offices 90</p> <p>Storage Areas 0</p> <p>Washrooms 0</p> <p>(Calculates demand based on occupancy in other spaces)</p> <p>Total DHW Load Peak: 160.8 l/h NECB D DHW</p>	
Mechanical Systems		
Indoor Design Temperature	<p>Occupied Spaces (offices, labs, classrooms, etc)</p> <ul style="list-style-type: none"> • Heating – 20°C; Setback 16°C • Cooling – 24°C; Setback 35°C <p>Unoccupied Spaces (Mechanical, storage, etc)</p> <ul style="list-style-type: none"> • Heating – 18°C <p>Electrical Spaces:</p> <ul style="list-style-type: none"> • Cooling – 24°C <p>Vestibules:</p> <ul style="list-style-type: none"> • Heating – 16°C <p>Source: mechanical team</p>	
HVAC System Description	System type 3: Single-zone packaged rooftop unit with baseboard heating	<p>DOAS-ERV: High performance energy recovery device with total effectiveness of 90+%. The DOAS will provide OA to the spaces through fan powered terminal boxes equipped with hot and chilled water coils.</p> <p>MUA: VAV make up air unit with hot water coil coupled with laboratory ducted hood vents</p> <p>ERV: Small energy recovery ventilator in loading bay / garbage room</p>

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	Reference Building (NECB 2017)	Proposed Design (Values based on design documents)
Total Ventilation Rates	Outdoor air (OA) flowrates 6 ACH for laboratory spaces and as per ASHRAE 62.1 for all other applicable spaces. Nighttime setback in laboratory spaces to 1 ACH.	
Supply Fan Power & Control	<p>Per NECB 2017 Section 8.4.4.18 (5) and NECB 2017 Section 5.2.3.1 (1b)</p> <p><u>System Type 3:</u> Supply & return fan combined: Fan power demand matches proposed model</p> <p><u>MUA</u> Supply: Fan power matches proposed model</p>	<p>Fan power as per preliminary selections: <u>2 x DOAS-ERV/Fan Coils:</u> Supply: Motor BHP = 4.72 kW, Supply Flow = 4,800 L/s, 100% OA Return: Motor BHP = 3.85 kW Fan Coils = 0.25 – 0.75 kW (varies on space)</p> <p><u>MUA</u> Supply: Motor HP = 0.205 kW, Supply Flow = 743 L/s, 100% OA</p> <p><u>ERV</u> Supply: Motor = 0.225 kW/ea., Supply Flow = 142 L/s, Mixed Air Return: Motor HP = 0.225 kW</p>
Ventilation Schedule	CAV, NECB D	VAV, NECB D
Heat Recovery	When required by NECB 2017 5.2.10 ERV Eff.: 50% Sensible, 50% Latent	DOAS: ERV Eff.: 94 % Sensible, 91.8% Latent Garbage Room: ERV Eff.: 88 % Total
Economizer	Control Settings: NECB 2017 Table A-5.2.2.8.(2)	N/A
Demand Control Ventilation	Not required	CO ₂ controlled DCV for DOAS system. All ventilated, occupied spaces (except laboratory spaces) include CO ₂ monitoring sensors for reducing ventilation requirements.
HVAC Central Plant		
Heating Type	Electric Resistance rooftop furnace	Flue gas economizer from campus energy center with two backup electric boiler
Heating Efficiency	100%	Flue gas economizer has an effective COP of 11.24 Conservatively calculated based on peak fan and pump power used in system to achieve the rated capacity of the unit
Cooling Type	DX cooling	Chilled water. Air cooled chiller w/ water-to-water heat pump for heat recovery
Cooling Efficiency	SEER 14	Rated COP 3.16



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	Reference Building (NECB 2017)	Proposed Design (Values based on design documents)
Domestic Water Heating Efficiency	DHW Electric Boiler, 100% Eff.	DHW Electric Boiler, 100% Eff

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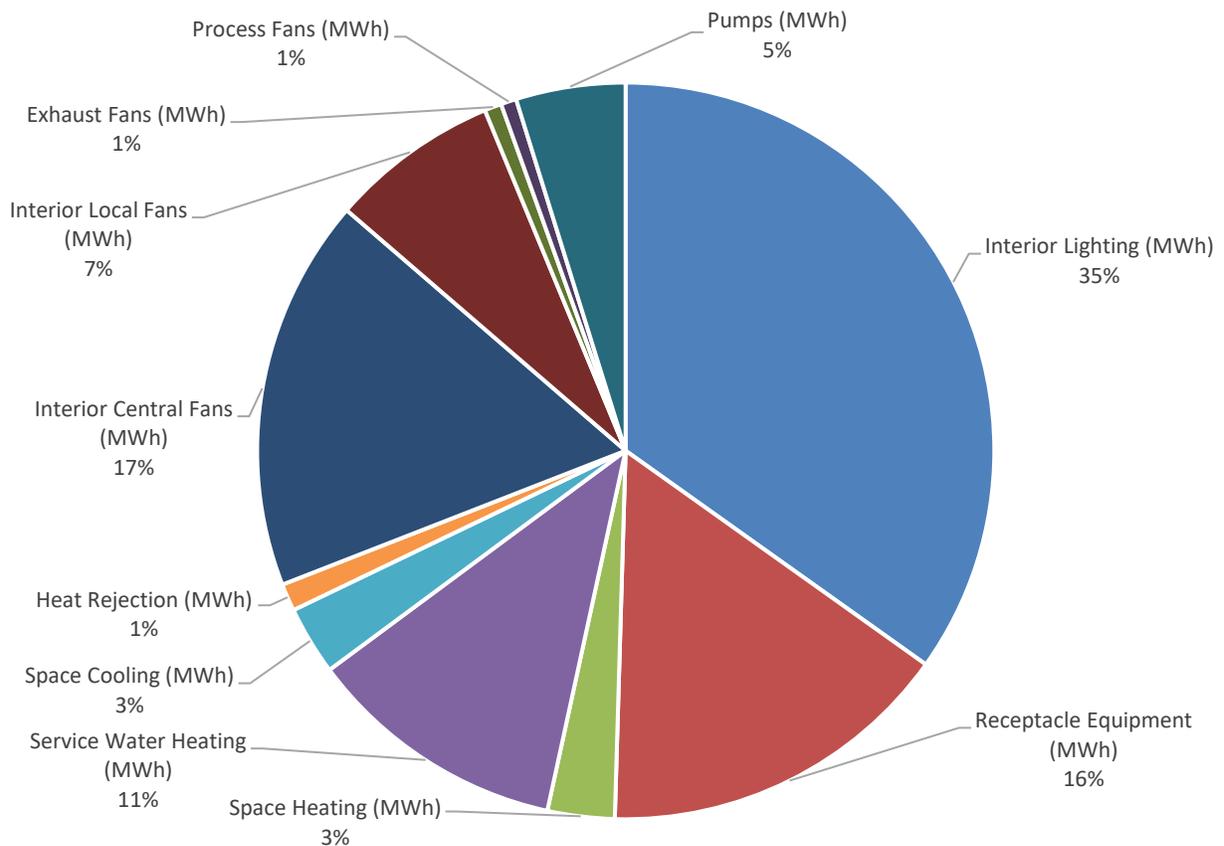
4.0 ANALYSIS AND RESULTS

This section summarizes the energy simulation study results. There are two different proposed models depending on the metric analyzed.

4.1 BUILDING ENERGY CONSUMPTION

Figure 2 shows the energy use breakdown of the proposed design. Fans and lighting are the biggest energy consumers for this building. Space heating energy consumption is very low for this building due to the very efficient energy recovery from both exhaust air and the campus boiler plant. Nearly all heating in this building is either recovered from the exhaust air or supplied via the campus boiler plant. In addition, the high performance envelope and air tight building further reduce the heating demand in the Polaris Project.

Figure 2 Energy Breakdown – Proposed



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Figure 2 Energy Consumption by End-Use (NECB 2017)

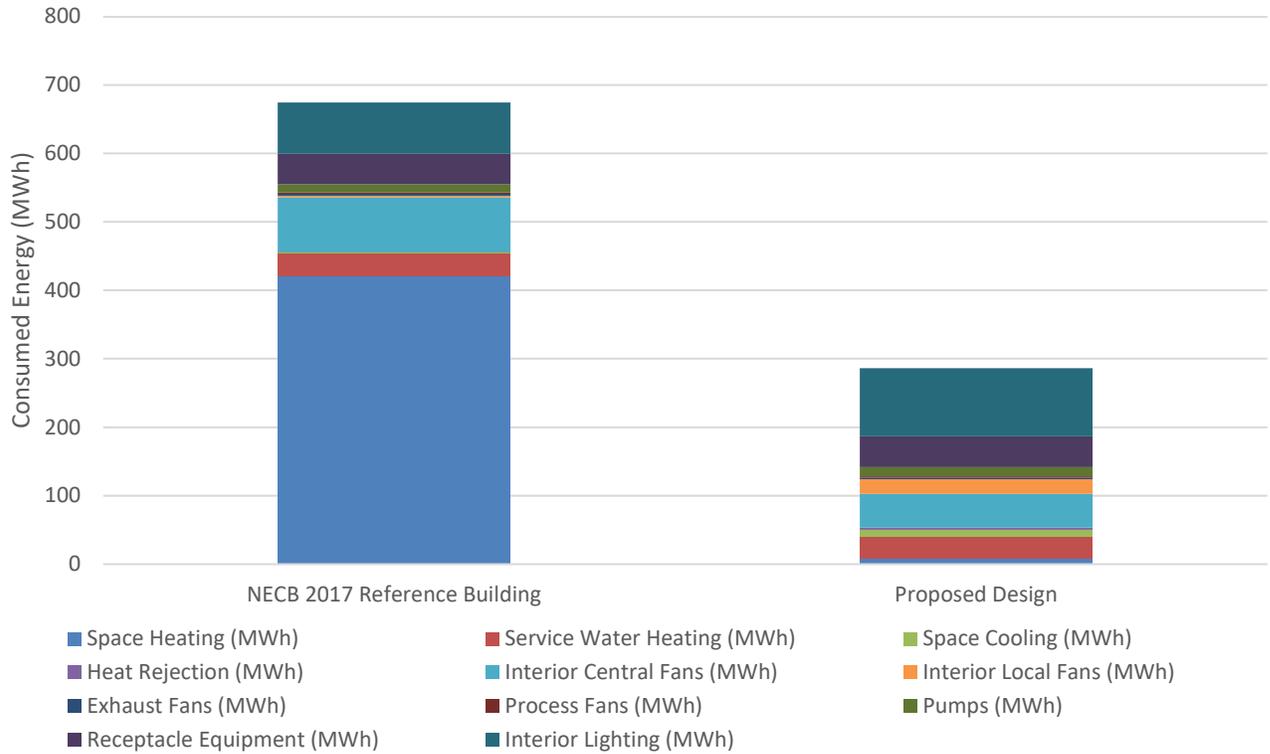


Figure 2 and Table 3 shows the energy breakdown of the proposed and reference model. The heating demand use achieves the highest energy savings. In total, the energy saving for the Polaris Project Project is 57.6% and therefore it is projected to comply with energy requirements of ZCB.3.

Table 3 Energy Consumption by End-Use in kWh

End-Use	Proposed (Economizer)	Proposed (Electric Boilers)	Reference (NECB 2017)	Savings ¹
Pump	13,762	15,105	11,783	-16.8%
Fan	74,766	74,439	86,845	14.2%
Space Cooling	8,640	8,387	1,918	-351%
Heat Rejection	3,437	3,094	122	-2,708%
DHW	32,791	32,791	32,791	0%
Space Heating	8,402	85,274	421,372	98.0%
Plug Loads	44,750	44,750	44,750	0%
Interior Lighting	99,777	99,777	74,973	-33.1%

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Total	286,326	363,617	674,554	57.6%
TEUI (kWH/m²)	100.7	127.9	237.4	57.6%

Note: Savings are calculated between the Reference model and the Proposed (Economizer) scenario

Table 3 shows the energy savings and energy cost savings compared to NECB 2017. The CaGBC ZCB requires that the building have a 25% improvement on energy savings compared to NECB 2017. The proposed designs achieve 57.6% energy savings when compared to the NECB 2017 reference building. Nearly all the savings are demonstrated to come from heating. A separate case was analyzed considering only electric boilers for heating purposes only for comparative reasons. Below outlines the justification for these savings.

- 1- Not all spaces require energy recovery in the NECB 2017 reference model while the proposed design uses a very high effective dual energy core that supports efficiencies of >90% tempering DOAS delivered air.
- 2- An effective COP of 11.24 on the flue gas energy recovery device. The COP was calculated based on the peak electrical demand on the pumps, fans and controls for the heat recovery loop compared to the flue gas energy recovery unit capacity of 200.8 kW. This COP of 11.24 is compared to the electric boiler efficiency of 1. The flue gas energy recovery device operates as a hot water loop with heat exchanger and not as a heat pump which is why the reference model is modelled with an electric boiler and not an air source heat pump.
- 3- The building envelope is very efficient. High thermal performance in all assemblies and fenestrations with minimal thermal bridges. The envelope also is designed to be airtight meeting passive house levels of infiltration. These together minimize the thermal heating demand significantly.
- 4- Demand control ventilation controlled via CO2 sensors limits the amount of OA that needs to be brought in and conditioned through periods of low occupancy during regular operating hours.
- 5- Efficient decoupling of space conditioning and ventilation tempering due to fan coils and DOAS system. Heating requirements in DOAS main heating coil nearly covered by energy recovery. Space heating requirements minimized by high performance envelope and then heated primarily through heat recovered from energy center flue gas.



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4.2 SUMMARY OF RESULTS - TEDI

Zero Carbon Building – Design Standard acknowledges that projects with unique heating and ventilation requirements, or that are in climate zones 7 or 8, can use an adjusted TEDI target. The laboratory spaces have unique ventilation rates.

The flexible Approach of the Zero Carbon Building Standard of Version 3 is pursuing an adjusted TEDI target, which is determined by area-weighting the TEDI requirement. The adjusted TEDI target is based on the floor area-weighted average of the NECB 2017 reference building TEDI value and the ZCB-Design TEDI target value.

- Modelled NECB 2017 reference building TEDI for Laboratory Spaces: 119.2 kWh/m²yr
- ZCB-Design TEDI target for climate zone 7: 36 kWh/m²yr

$$\text{TEDI}_{\text{adjusted}} = \frac{\sum(\text{TEDI} [\text{kWh}/\text{m}^2\text{year}] \times \text{Modelled Floor Area} [\text{m}^2])}{\text{Total Modelled Floor Area} [\text{m}^2]}$$

$$\text{TEDI}_{\text{adjusted}} = \frac{119.2 \text{ kWh m}^2\text{year} \times 738 \text{ m}^2 + 36 \text{ kWh m}^2\text{year} \times 2,104 \text{ m}^2}{2,842 \text{ m}^2}$$

Adjusted TEDI target for entire building based on ZCB-Design v3 Energy Modelling Guidelines:

$$\text{TEDI}_{\text{adjusted}} = 57.6 \text{ kWh}/\text{m}^2\text{year}$$

Please note that the table below shows the TEDI calculation completed for the NECB proposed modelling scenario which considers infiltration based on 0.25 L/s/m² of above grade wall and roof area (NECB Section A-8.4.3.3.(3) and also the proposed airtightness target of 0.6 Air Changes per Hour (ACH) as per Passive House guidelines.

Table 4 ZCB Standard TEDI Requirements (Whole Building)

Project	Proposed TEDI (0.6 ACH)	Proposed TEDI (NECB 2017)	ZCB TEDI Requirements	Compliant (Y/N)
Polaris	35.2	70.4	57.6	Yes

To provide sensitivity analysis, TEDI was calculated for areas that have conventional heating and ventilation requirements (e.g. offices, retails space, etc.). This was compared to the TEDI target of 36 KWH/m² as prescribed for climate zone 7 in the ZCB guideline. The TEDI result for these areas are as below:

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Table 5 ZCB Standard TEDI Requirements (Non Laboratory Areas)

Project	Proposed TEDI (0.6 ACH)	ZCB TEDI Requirements	Compliant (Y/N)
Polaris (non laboratory spaces)	28.1	36	Y

The analysis shows that the non-laboratory portion of the building does meet the TEDI target of 36 kWh/m². A description of findings are stated as below:

- Effective demand control ventilation reducing the overall heating demand;
- Increased air tightness limiting infiltration to the building. This results in reduced skin loss and greater heat retention thereby reducing the heating demand.

4.3 SUMMARY OF RESULTS – GHG and Zero Carbon

As part of the process to be certified under CaGBC Zero Carbon Building standard is that the design needs to be operationally zero carbon. This requires that the carbon emissions associated with the operation of this building to be offset via purchased carbon offsets or by renewable electricity generation (on-site PV).

Table 6 ZCB Standard TEDI Requirements

Electrical Emission Factor	Marginal Emission Factor	Electricity Consumed	Choose One Path Below		
			Annual Purchased Offset Requirements	Exported Green Power Requirement	Annual Onsite PV Generation
120 g CO ₂ e/kWh	843 g CO ₂ e/kWh	286,326 kWh	24 tons	29,000 kWh	286,326 kWh

There are three paths available for the Polaris Project to achieve operational zero carbon.

1. Purchase 24 tons of carbon offsets annually for life of building (or length of certification). Average prices at time of report show \$20 (USD) / ton which is about \$480 annually. These prices are subject to change and in the past year have been as low as \$4 / ton to as high as \$40 / ton.
2. On-site renewable energy generation exporting 29,000 kWh annually to the local grid. This offsets the grid's marginal emissions equivalent to the emissions generated through annual operations of the building. On-site renewable energy generation will be calculated on an hour-by-hour basis to determine what is offsetting building energy consumption and what is exported.



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3. On-site generation offsetting 100% of the energy consumed on the site, with zero electricity exported back to grid. This would be a net-zero energy design where all of the energy generated is used in the building.

4.4 Embodied Carbon Analysis

An analysis of the embodied carbon for Polaris has been included and the full report is attached in Appendix A. Part of the requirements for CaGBC ZCB is the reporting and offsetting of embodied carbon that exists in the materials of the building. Embodied carbon is the amount of carbon that is generated for building materials through acquisition, transportation, manufacturing and construction. CaGBC ZCB v3 requires less than 500 kg CO₂e/m². The analysis shows that we are 345 kg CO₂e/m² which awards an innovation credit for being less than 350 kg CO₂e/m².

This embodied carbon must be offset through purchased carbon offsets within the first 5 years of occupancy. Most projects will offset this carbon using the construction capital in a one-time payment prior to building occupancy. Using current offset pricing, this value will be \$19,894 (@ \$20 per tonne of emissions).

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4.5 Discussion

As Polaris is currently designed, it exceeds the operational performance requirements set by CaGBC Zero Carbon Building Standard. There exists 3 paths to offset the carbons associated with the operations of this building which are all feasible.

The next steps for certification are shown below:

ZCB V3 DESIGN CRITERIA	TARGET	Next Step
Thermal Energy Demand Intensity (TEDI)	36 kWh/m ² /yr	On Track. Update at IFC
Site Energy Use Intensity	25% better than NECB 2017	On Track. Update at IFC
Zero Carbon Balance	Model zero carbon balance	To be complete with updated solar design. Energy modeling, hourly solar PV modeling, and life cycle assessment included in design scope to model the three components of the zero carbon balance
Embodied Carbon	Report absolute embodied carbon intensity < 500 kg CO ₂ /m ²	On track. To be updated at 100% CD
Refrigerants	Report total quantity	To be quantified. Refrigerant reporting to be complete by IFC
RECs and Carbon Offsets	Provide quote	To be determined at 100% CD once zero carbon balance is determined. Quotes for embodied and operational carbon offsets will be sourced once carbon balance is modeled
Onsite Combustion	None or provide transition plan	On track. Design targets no onsite combustion.
Impact and Innovation	Apply two strategies	On track for the following: 1. Onsite renewable energy generating >5% of total energy. Helioscope to be complete once final geometry is designed. 2. Space heating systems completely without combustion 3. Reduction in embodied carbon. < 350 kg Co ₂ /m ²



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Appendix A Embodied Carbon Analysis

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**Zero Carbon Building Version 3
Embodied Carbon Report - Polaris
January 23, 2023**



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1. INTRODUCTION

The purpose of this reporting template is to outline the information that is required to be submitted in the embodied carbon report that is required for ZCB-Design v3 certification. Projects may complete this template or provide a custom report that meets the information needs specified herein.

2. GENERAL INFORMATION

General Information	
Project Name	Polaris
Embodied Carbon Assessor	Oscar Valdes
Firm	Stantec Consulting
Date of Assessment Completion	1/23/2023
Software & Version Number	OneClickLCA (Traci v2.1)
Project Life	<input checked="" type="checkbox"/> 60 year
Assessment Timing (check all that apply)	<input checked="" type="checkbox"/> Schematic Design (Based on Class D costing estimate dated 11/17/2022) <input type="checkbox"/> Design Development <input type="checkbox"/> Construction Documents
Please confirm that the analysis includes all structural and envelope components (“mandatory materials”) by checking the applicable boxes to the right.	<input checked="" type="checkbox"/> Footings and foundations <input checked="" type="checkbox"/> Complete structural wall assemblies (cladding to finish) <input checked="" type="checkbox"/> Structural floors and ceilings (no finishes) <input checked="" type="checkbox"/> Slab on grade <input checked="" type="checkbox"/> Roof assemblies <input checked="" type="checkbox"/> Stairs <input type="checkbox"/> Parking structure (not including surface parking)
Please list any additional materials that are included at the applicant’s discretion.	N/A

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3. CARBON EMISSIONS FOR EACH LIFE CYCLE STAGE

Provide the following breakdown by life cycle stage. If the software used does not provide values for every stage, leave the missing ones blank.				Carbon Emissions from Mandatory Materials (kg CO ₂ e)	Carbon Emissions from Optional Materials (kg CO ₂ e)
Life Cycle Stage					
Upfront	Product	A1	Raw Material Supply	720,901	0
		A2	Transport (to factory)		0
		A3	Manufacturing		0
	Construction	A4	Transport (to site)	58,450	0
		A5	Construction & Installation	108	0
			Total Upfront Carbon		779,459
Use		B1	Use	0	0
		B2	Maintenance	0	0
		B3	Repair	0	0
		B4	Replacement	89,650	0
		B5	Refurbishment		0
			Total Use Stage Embodied Carbon		89,650
End of Life		C1	Demolition	9,639	0
		C2	Transport (to disposal)	9,498	0
		C3	Waste Processing	89,906	0
		C4	Disposal	176	0
			Total End of Life Carbon		109,216
Optional, does not need to be offset:					0
Beyond the Life Cycle	D	Reuse		N/A	0
	D	Recycling		N/A	0



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	D	Energy Recovery	N/A	0
		Total Beyond the Life Cycle Carbon	N/A	0

4.6 3.1 Contribution Analysis

Please provide a contribution analysis, broken out to the best of your ability by either material type or building assembly type. The list must include the top 10 contributing items at a minimum (concrete can only count as one, although multiple mix types can be listed separately).	
Material or Building Assembly	Carbon Emissions (kg CO₂e)
21-02 30 10 Roofing	298,358
21-01 10 10 Standard Foundations	295,112
21-02 20 10 Exterior Walls	151,330
21-02 10 20 20 Roof decks, slabs, and sheathing	91,046
21-02 20 20 Exterior Windows	46,303
21-02 10 10 10 01 Floor Structural Frame - Beam	43,380
21-02 10 10 10 02 Floor Structural Frame - Column	16,426
21-02 10 20 10 Roof Structural Frame	10,083
21-01 20 10 Walls for Subgrade Enclosures	8,116
21-02 20 50 Exterior Doors and Grilles	638

4.7 3.2 Conclusion

The analysis shows that the project has a global warming potential (GWP) intensity of 345 kgCO₂e/m²/year and is on track to meet the minimum ZCB v3 absolute target requirement of 500 kgCO₂e/m²/year and the 350 kgCO₂e/m²/year Innovation credit threshold. The analysis will be updated during the Construction Documents phase to verify the requirements are still met.

4.8 3.3 Bill of Materials

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Main > Polaris > Proposed > Life Cycle Carbon - North America (Imperial units) > Input data : Building materials



Building materials
Construction site operations
Energy consumption, annual
Water consumption, annual
Calculation period
Emissions and removals
Buil

Filter: Filter: Filter: Filter: Filter:

Fill in the material consumptions by material type. You may fill in all materials lumped together, or on separate rows for example by type of structure. Unless instructed otherwise, use gross amounts (incl. losses). Materials can be added in any section. [Material selection help](#).

Completeness (%) and plausibility checker (-)

1. Foundations and substructure 311 Tonnes CO₂e - 32 %

Materials in the foundations will never be replaced, no matter assessment period length. For BREEAM UK Mat 1 IMPACT equivalent provide the data for site excavation fuel use here, choose resource Excavation works.

Foundation, sub-surface, basement and retaining walls Create a group Move materials Add to compare

Start typing or click the arrow

Resource	Quantity	CO ₂ e	Comment	Omniclass	Transport, miles (A4)
Ready-mix concrete, 25MPa Industry ?	383 m3	155t - 16%	SOG 125 mm thick	21-01 10 10. Standard	200 Concrete mixer
Reinforcement steel (rebar), generi ?	18388 kg	7.8t - 0.8%	SOG 125 mm thick	21-01 10 10. Standard	580 Trailer combina
XPS insulation, 15 psi, R-10 (Rsi = ?	2919 m2 x 2 in	93t - 10%	SOG 125 mm thick	21-01 10 10. Standard	350 Trailer combina
XPS insulation, 15 psi, R-10 (Rsi = ?	133 m2 x 3 in	6.4t - 0.7%	SOG 125 mm thick	21-01 10 10. Standard	350 Trailer combina
High performance vapor barrier, 0.0 ?	2919 m2 x 0.020 in	8.6t - 0.9%	SOG 125 mm thick	21-01 10 10. Standard	350 Trailer combina
Aggregate (crushed gravel), generic ?	438 m3	3.5t - 0.4%	SOG 125 mm thick	21-01 10 10. Standard	30 Dump truck, 19
Ready-mix concrete, 25MPa Industry ?	21 m3	8.5t - 0.9%	SOG Thickening below	21-01 10 10. Standard	200 Concrete mixer
Reinforcement steel (rebar), generi ?	1344 kg	0.57t - 0.1%	SOG Thickening below	21-01 10 10. Standard	580 Trailer combina
Aggregate (crushed gravel), generic ?	460 m3	3.8t - 0.4%	SOG Thickening Below	21-01 10 10. Standard	30 Dump truck, 19
Ready-mix concrete, 25MPa Industry ?	29 m3	12t - 1%	Interior Slab Thick	21-01 10 10. Standard	200 Concrete mixer
Reinforcement steel (rebar), generi ?	1820 kg	0.77t - 0.1%	Interior Slab Thick	21-01 10 10. Standard	580 Trailer combina
Aggregate (crushed gravel), generic ?	357 m3	2.8t - 0.3%	Interior Slab Thick	21-01 10 10. Standard	30 Dump truck, 19
Ready-mix concrete, 25MPa Industry ?	18 m3	7.3t - 0.7%	Base. Wall 200 mm	21-01 20 10. Walls for Subgrade	200 Concrete mixer
Reinforcement steel (rebar), generi ?	2000 kg	0.85t - 0.1%	Base. Wall 200 mm	21-01 20 10. Walls for Subgrade	580 Trailer combina
Ready-mix concrete, 25MPa Industry ?	1 m3	0.4t - -0%	Pilaster 28x43	21-01 10 10. Standard	200 Concrete mixer
Reinforcement steel (rebar), generi ?	463 kg	0.2t - -0%	Pilaster 28x43	21-01 10 10. Standard	580 Trailer combina

2. Vertical structures and facade 215 Tonnes CO₂e - 22 %



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External walls and facade 📁 Create a group ➕ Move materials 🔍 Add to compare						
Start typing or click the arrow <input type="text"/>						
Resource	Quantity	CO ₂ e	Comment	Omniclass	Transport, miles (A4)	
Roll formed steel cladding, 2.77 kg ?	1176 m2	18t - 2%	A.A32.1&	21-02 20 10. Exterior Walls	580	Trailer combin
Aluminium composite panel, polyethy ?	545 m2	36t - 4%	A.A32.5&A.A32.6	21-02 20 10. Exterior Walls	350	Trailer combin
Rock wool insulation batt for wood ?	1176 m2 x 5 in	4.5t - 0.5%	A.A32.1&	21-02 20 10. Exterior Walls	200	Trailer combin
Acrylic-based membrane, fluid appli ?	2352 m2 x 0.025 in	32t - 3%	A.A32.1&	21-02 20 10. Exterior Walls	350	Trailer combin
Moisture and mould resistant Type X ?	1176 m2	2.1t - 0.2%	A.A32.1&	21-02 20 10. Exterior Walls	200	Trailer combin
Wooden stud framing for drywall/gyp ?	1176 m2	1.8t - 0.2%	A.A32.1&	21-02 20 10. Exterior Walls	560	Trailer combin
Rock wool insulation batt for wood ?	1176 m2 x 5.5 in	5t - 0.5%	A.A32.1&	21-02 20 10. Exterior Walls	200	Trailer combin
Glass-mat gypsum boards, moisture a ?	1176 m2	7.5t - 0.8%	A.A32.1&	21-02 20 10. Exterior Walls	200	Trailer combin
Roll formed steel cladding, 2.77 kg ?	509 m2	7.9t - 0.8%	A.A32.2 & A.A32.4	21-02 20 10. Exterior Walls	580	Trailer combin
Aluminium composite panel, polyethy ?	81 m2	5.3t - 0.5%	A.A32.7	21-02 20 10. Exterior Walls	350	Trailer combin
Rock wool insulation batt for wood ?	590 m2 x 5 in	2.3t - 0.2%	A.A32.2 &	21-02 20 10. Exterior Walls	200	Trailer combin
Acrylic-based membrane, fluid appli ?	1180 m2 x 0.025 in	16t - 2%	A.A32.2& A.A32.4&A.A32.7	21-02 20 10. Exterior Walls	350	Trailer combin
Moisture and mould resistant Type X ?	590 m2	1.1t - 0.1%	A.A32.2& A.A32.4&A.A32.7	21-02 20 10. Exterior Walls	200	Trailer combin
Wooden stud framing for drywall/gyp ?	590 m2	1.1t - 0.1%	A.A32.2& A.A32.4&A.A32.7	21-02 20 10. Exterior Walls	560	Trailer combin
Rock wool insulation batt for wood ?	590 m2 x 5.5 in	2.5t - 0.3%	A.A32.2& A.A32.4&A.A32.7	21-02 20 10. Exterior Walls	200	Trailer combin
Glass-mat gypsum boards, moisture a ?	590 m2	3.7t - 0.4%	A.A32.2& A.A32.4&A.A32.7	21-02 20 10. Exterior Walls	200	Trailer combin
Fiberglass windows, 1.5m x 1.3 m, 4 ?	288 m2	46t - 5%	Windows	21-02 20 20. Exterior Windows	650	Trailer combin
Aluminium doors, 32 kg/m2 (AluQuébe ?	33.6 m2	4.5t - 0.5%	7 double glazed doors	21-02 20 10. Exterior Walls	580	Trailer combin
Steel doors with polyurethane core, ?	2 unit	0.64t - 0.1%		21-02 20 50. Exterior Doors and	550	Trailer combin
Columns and load-bearing vertical structures 📁 Create a group ➕ Move materials 🔍 Add to compare						
Start typing or click the arrow <input type="text"/>						
Resource	Quantity	CO ₂ e	Comment	Omniclass	Transport, miles (A4)	
CLT produced in British Columbia, 4 ?	16 m3	2t - 0.2%	CLT Shear Walls	21-02 10 10 10 02. Floor	560	Trailer combination, 40
Glue laminated timber (Glulam), 467 ?	70.0 m3	14t - 1%	Glulam columns	21-02 10 10 10 02. Floor	560	Trailer combination, 40
Internal walls and non-bearing structures 📁 Create a group ➕ Move materials 🔍 Add to compare						
Start typing or click the arrow <input type="text"/>						

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3. Horizontal structures: beams, floors and roofs 443 Tonnes CO₂e - 45 %

Floor slabs, ceilings, roofing decks, beams and roof Create a group Move materials Add to compare

Start typing or click the arrow

Resource	Quantity	CO ₂ e	Comment	Omniclass	Transport, miles (A4)
Glue laminated timber (Glulam), 467 ?	210 m3	43t - 4%	Glulam beams	21-02 10 10 10 01. Floor	580 Trailer combinati
Bitumen roofing, SBS modified, self ?	2919 m2	15t - 2%	SBS membrane	21-02 30 10. Roofing	350 Trailer combinati
Gypsum board with glass mat sheath ?	2919 m2	21t - 2%	Cover board	21-02 10 20 20. Roof Decks	200 Trailer combinati
Rock wool insulation for low-slope ?	220 m3	29t - 3%	semi-rigid wool	21-02 30 10. Roofing	200 Trailer combinati
PIR (polyisocyanurate foam) insulat ?	2919 m2 x 8 in	214t - 22%	Polyiso insulation	21-02 30 10. Roofing	350 Trailer combinati
Acrylic-based membrane, fluid appli ?	2919 m2 x 0.025 in	40t - 4%	Membrane	21-02 30 10. Roofing	350 Trailer combinati
Softwood plywood, 477.33 kg/m ³ (Can ?	25 m3	5.2t - 0.5%	Spruce plywood sheathing	21-02 10 20 20. Roof Decks	560 Trailer combinati
Prefabricated truss from softwood ?	50 m3	10t - 1%	T&G Deck	21-02 10 20 10. Roof Structural	560 Trailer combinati
Steel roof and floor deck, North Am ?	28628 kg	65t - 7%	Steel Deck	21-02 10 20 20. Roof Decks	580 Trailer combinati

4. Other structures and materials - out of scope - Add to scope

5. External areas and site elements - out of scope - Add to scope

