TECHNICAL SPECIFICATIONS FOR :

PROJECT: # MISSISSAUGA FIRE STATION 124

PROJECT No.: 23116

TENDER No.: PRC004616

DATE: JULY 2024

BINDER: # B MECHANICAL, ELECTRICAL & SOLAR PV SYSTEM

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City of Mississauga
Fire Station 124
EXP Services Inc.
Project ALL-23003797-A0 PRC004616

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END OF SECTION

Part 1 - General

1.1 RELATED SECTIONS

.1 Divisions 21, 22, 23, 25

1.2 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings to show:

- .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.
- .6 Approvals:
  - .1 Submit two (2) copies of draft Operation and Maintenance Manual to Consultant for review. Submission of individual data will not be accepted unless directed by Consultant.
  - .2 Make changes as required and re-submit as directed by Consultant.

1.3 DELIVERY, STORAGE & HANDLING

.1 Transport, store and handle the materials in conformance with the manufacturer's instructions.

.2 Delivery and receipt:

- .1 Deliver the materials to the job site in their original packaging. The name and the address of the manufacturer marked must be labelled on the packaging.

.3 Storage and protection:

- .1 Store the materials in a dry environment.
- .2 Store the materials in the temperature and humidity conditions recommended by the manufacturer, and protect them from exposure to extreme weather conditions.

.4 Packaging waste management: recover the packaging waste so that it may be re-used or recycled, or reclaimed by the manufacturer. This includes pallets, lockers, packing and other packing material.

1.4 RELATED WORK

.1 It is the intent of these specifications to furnish and install all materials and equipment as hereinafter specified and/or as shown on the drawings in such a manner as to leave each of the systems of the mechanical trades complete and in satisfactory condition.

.2 Where used, words "Section" and "Division" shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.

.3 Where used, word "supply" shall mean furnishing to site in location required or directed complete with accessory parts.

.4 Where used, word "install" shall mean secured in place and connected up for operation as noted or directed.

.5 Where used, word "provide" shall mean supply and install as each is described above.

.6 Where used, word "Authorities", shall mean any agency that enforces the applicable laws, ordinances, rules, regulations or code of the place of the work.

.7 Where used, word "work" shall mean all equipment, permits, materials and labour to provide a complete mechanical installation as required and detailed in the Drawings and Specifications.

.8 Where used, word "Consultant" shall mean the project architect.

.9 Where used, words "Drawings" and "Specifications" are referred to; it means the "Contract Documents".

.10 Where used, words "Prime Mechanical Contractor" shall mean the supervisory Mechanical Contractor of all Mechanical Sub-Contractors.

.11 The terms "instructions" or "as instructed" or "where instructed" mean as instructed by the Consultant, including supplementary instruction notices; job site instruction notices; job site instructions by a field representative/ inspector appointed by the Consultant and including all comments made regarding submittal of shop drawings and samples for review.

.12 The term "exposed" means, within the line of sight of any person standing or sitting in the occupied space, unless defined otherwise in the following sections.

.13 The term "concealed" means, not exposed.

.14 The term "listed" means, that the materials or equipment are tested in accordance with applicable standards, and are approved and listed for their intended use by a testing company approved by the Authorities having jurisdiction.

.15 The term "approved", "approvals", etc., means, approved by Authorities having jurisdiction as conforming to the requirements of the Contract Documents.

.16 The term "acceptable" or "acceptance", etc., means, acceptable to the Consultant as conforming to the requirements of the Contract Documents.

.17 The term "submit for review" or "submit notice", etc., means, submit to the Consultant.

.18 The term "subject to review" means, work or materials laid out for review by the Consultant. Obtain instruction from the Consultant before proceeding with the work. Submit further information, shop drawings, samples etc., as specified and/or as may be reasonably requested by the Consultant.

.19 The term "accessible" used alone means, readily accessible by a person using tools as required without cutting or breaking out materials.

.20 The term "noted" means, notes on the drawings, the detail drawings and on the Schedules.

1.5 **DISCREPANCIES & OMISSIONS**

.1 The specifications are to be considered as an integral part of the plans which accompany them; neither the plans nor the specifications shall be used alone. Any item or subject omitted from one, but which is mentioned or reasonably implied in the other, shall be considered as properly and sufficiently specified, and must therefore, be provided. Notify the Consultant in wiring of any discrepancy between the drawings and the Specifications. Misinterpretations of either the plans or the specifications shall not relieve the Prime Mechanical Contractor of responsibility.

1.6 **INSPECTION OF PREMISES & SITE**

.1 Visit the site of the building and become thoroughly familiar with all the conditions to be met in carrying out the work covered by these specifications. No extras will be allowed for failure to properly evaluate conditions which affect the scope of the Work included in Divisions 21, 22, 23 and 25.

1.7 **INTERPRETATION OF DRAWINGS**

.1 The drawings upon which this contract is based show the arrangements, general design and extent of the piping, ductwork and other systems. These systems are suitably outlined on the drawings with regard to sizes, locations, general arrangement and installation details. The mains and connections thereto are shown more or less in diagram, except where in certain cases, the drawings may include details giving the exact locations and arrangements required. All piping and ductwork shall be concealed unless shown otherwise. The Mechanical Contract Drawings do not intend to show Architectural or Structural details.

.2 Where any parts of the system and/or pieces of equipment are located by dimensions on the drawings, said dimensions shall be checked and verified in the field. Each Division shall make without additional charge or expense to the Owner, any necessary changes, additions or offsets to the runs to accommodate structural conditions. The Consultant shall be notified immediately and his authority secured in writing for such revisions before proceeding with the work.

.3 As the work progresses, and before installing fixtures and other fittings and equipment which may interfere with the work of other trades, each Contractor shall consult with the Consultant and obtain detail drawings or instructions for the exact location of such equipment.

1.8 **RECORD DRAWINGS**

.1 As the project progresses, record, on a set of white prints, all addenda, changes to and deviations from the plans made during the Construction period. Also, record the location of all light fixtures and other electrical equipment and wiring for same.

.2 Make these Progress Record Drawing white prints available to the Consultants for their review at all times during the Construction period.

.3 At the conclusion of the project, transfer all Record Drawing information to a USB.

.4 The Consultant shall provide to the Contractor, a USB containing graphic (electronic) representation of the Drawings. Complete and return the release form "Transfer of Files on Electronic Media" in order to receive and use the electronic files.

.5 Before Substantial Performance of the Contract, comply with the following:

.1 Provide USB containing all updated record Drawing information as specified herein.

1.9 **INTERFERENCE DRAWINGS**

.1 Before shop fabrication begins or undertaking installation work inside the building, prepare an integrated set of mechanical interference sketches, where indicated on the drawings.

.2 These sketches shall be prepared by the Prime Mechanical Contractor with the co-operation of other trades and shall show the location or space allocated for the work of each trade.

.3 Submit two (2) copies of detailed interference sketches, showing structural members, electrical conduits, devices and all Mechanical elements to the Consultant for review and general approval before proceeding with the work.

.4 Copies of these reviewed interference drawings shall be submitted to all trades, the General Contractor, the Architect, and the Consultant, and general approval shall be obtained before the space allotment and installation.

.5 As a minimum, interference drawings shall be made for all areas of mechanical equipment rooms, duct shafts and ceiling spaces.

.6 Work that has been installed before review of interference drawings, and has been determine that it is in conflict with the building, shall be removed from the site at no extra cost to the Owner. The work, approved by the Consultant, shall be installed at no extra cost to the Owner.

1.10 **MANUFACTURERS SHOP DRAWINGS & SUBMITTALS**

.1 Before fabrication of any materials and/or equipment, submit shop drawings and data sheets covering all items of equipment listed as requiring shop drawings. Shop drawings to be submitted are listed in each section under SUBMITTALS. These will be reviewed and returned to the Contractor. Materials shall not be ordered until "accepted" review has been given.

.2 The Prime Mechanical Contractor is to consult with the Consultant on the manner in which drawings will be handled. Supply metric information for metric projects.

.3 Equipment requiring electrical wiring by Division 26 will have the electrical wiring diagrams submitted with the shop drawings. Shop drawings will not be reviewed unless wiring diagrams accompany the equipment drawings.

.4 For whiteprint-type shop drawings, eight (8) copies as required. For 8-1/2" x 11" fixture cuts, submit eight (8) copies of booklets as required. For electronic submissions, one (1) copy is required.

.5 The Prime Mechanical Contractor is to keep track of the shop drawings and the subsequent equipment delivery using a Review Summary Form. This form is to be updated and presented at each job meeting until all the equipment is on the job.

.6 The shop drawings must apply to the equipment under consideration. Advertising literature and comprehensive data sheets are not acceptable.

.7 The shop drawings must contain the following information: job name, equipment tag, actual dimensions of unit and dimensioned location and size of all field connections, model, performance curves, capacity, HP, voltage and all accessories listed in the specifications and/or being provided, and the operating points of the proposed equipment. Room schedules are to be provided for multiple units.

.8 The shop drawings submitted for review must first be carefully checked by the Prime Mechanical Contractor and bear the Contractor's identification review stamp or signature. Drawings will not be considered otherwise.

.9 Shop drawing review is for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the contract documents. Contractor is responsible for the dimensions which shall be confirmed and correlated at the job site; fabrication processes and techniques of construction; coordination of his or her work with that of all other trades; and the satisfactory performance of his or her work.

.10 Shop drawings will be returned "No Exception Taken", "Revise & Resubmit", "Make Corrections Noted, Resubmission Not Required" or "Rejected, Submit Compliant Product/System".

.1 "No Exception Taken" Drawings shall be considered as conforming with the design concept.

.2 "Make Corrections Noted, Resubmission Not Required" Drawings shall be considered as conforming with the design concept once corrections have been made as noted on the drawings. This notation shall not hold up manufacture. These drawings shall be corrected for final submission with project Maintenance/Operation manuals.

.3 "Revise & Resubmit" Drawings shall be considered as conforming with the design concept once corrections have been made as noted on the drawings. These drawings shall be corrected and resubmitted for final review but such resubmission shall not hold up manufacture.

.4 "Rejected, Submit Compliant Product/System" These drawings are rejected and work shall not proceed on the manufacture of this equipment. The drawings shall be re-drawn or corrected, and resubmitted with corrections as noted on the drawings or a letter attached thereto.

.11 All shop drawings must be submitted promptly.

1.11 **MAINTENANCE & MAINTENANCE MANUALS**

.1 During the one (1) year guarantee period, commencing after Substantial Completion Letter has been issued by the Consultant's Office, maintain all equipment installed as part of the Mechanical Divisions. This is to include lubrication of bearings, cleaning of strainers, etc., except the replacement of air filters and water treatment. This agreement shall be part of the written guarantee. This work shall be carried out in the presence of the owner's representative, and a letter shall be sent to the Consultant stating that this work was carried out. Three (3) maintenance inspections must be carried out by the Prime Mechanical Contractor during this one (1) year period, evenly spaced over the time frame. (after Substantial Completion Letter issued by the Architect). Submit written report to Owner and Consultant after each inspection.

.2 This maintenance shall continue up to the date of instruction of the Owner's designated representatives, at which time each piece of equipment is to be lubricated and checked in the presence of the Owner's representative(s).

.3 Not later than three (3) weeks prior to application for inspection by Consultant for Substantial Performance, submit records and maintenance manuals to Consultant.

.4 Prepare two (2) sets of "letter" sized, hard-cover, three-ring, black, maintenance manuals, containing dimensioned certified prints of each piece of mechanical equipment and Manufacturer's recommended maintenance instructions, air balancing reports, and wiring diagrams. Tabulated at the front of this binder is to be a maintenance schedule for each piece of equipment, and lubricant to be used, and a tabulation of things to be checked at each piece of equipment.

.5 Maintenance Manuals will be requested by the Consultant shortly after the final submission of all shop drawings. Maintenance manuals must be submitted and reviewed before training of the Owner's personnel and before a final inspection will be carried out.

1.12 **ELECTRICAL WIRING & WIRING DIAGRAMS**

.1 All motors for equipment under Mechanical Divisions will be by the Prime Mechanical Contractor. All starters, switches and power wiring will be provided by Division 26, as noted. Where electrical requirements for equipment exceed the provisions described in electrical specifications, this Contractor shall provide labour and material as required to complete the installation. All motors, switches and equipment shall be of Canadian manufacture: Westinghouse Canada, Canadian General Electric, Allen-Bradley, Square 'D', Robins & Meyers, Lincoln, Tamper.

.2 Provide with shop drawings, a comprehensive wiring diagram for all mechanical equipment requiring review. Shop drawings will not be reviewed unless accompanied by the wiring diagrams.

1.13 **ACCESS PANELS & DOORS**

.1 Provide access panels in ceilings, walls, etc., as required and as indicated. Size panels as required and as indicated.

.2 Access panels shall be prime coated steel with hinged, latched door. Latch shall be keyless, i.e. opened with screwdriver only.

.3 Access doors, whose locations are such that they will be visible to public and staff (with the exception of those located within service rooms such as Mechanical, Electrical, Sprinkler, Janitor, Storages and Elevator Machine Room) shall be Mifab CAD Series recessed-type access door, suitable for receiving gypsum wall board, wood panel and/or tile for a flush finish at walls and ceilings. Coordinate access door depth with depth of wall and ceiling finish. Provide fire-rated type access door when access door is located in fire-rated walls.

1.14 **CONCRETE WORK & SUPPORTS**

.1 Installation of concrete bases for all mechanical equipment shall be by the General Division.

.2 Prime Mechanical Contractor shall provide accurate templates for the concrete trade to pour the bases.

.3 For equipment suspended from the building structure, provide all structural members, platforms, brace and hanger rods as required. Method of attachment to be reviewed with the Structural Consultant before proceeding with the installation.

1.15 **FLASHING**

.1 The Prime Mechanical Contractor shall provide flashings for the work of the Mechanical Divisions. If not specified, a description is to be supplied for approval.

.2 Generally, all pipes and small ducts or stacks passing through the roof shall be flashed with an 18 gauge steel sleeve soldered watertight and fastened to the roof deck before the roofing is applied with a minimum of 8" (200 mm) overlap along the roof deck and extending 8" (200 mm) up the pipe or duct, sealed with a weather skirt.

.3 Vent stacks may be flashed with patented flashing cones provided with the equipment.

.4 Where large ducts pass through roof, curbs and flashing shall be by the Prime Mechanical Contractor where shown on the roofing plan. If not shown, all curbs, flashings and counter flashing are by the Prime Mechanical Contractor.

1.16 **PAINTING**

.1 Mechanical equipment, grilles, fans, shall be shop prime coated unless noted to be finish coated. Where the prime coat or finish coat has been marred, touch up the surface.

.2 Equipment exposed to the exterior weather conditions are to be shop finished with rust-resistant paint or as specified in equipment specification.

.3 Leave all work in a clean, paintable condition.

.4 All exposed structural members required for supporting piping, ductwork and equipment shall be galvanized. Where threaded rods are used, they shall be cadmium plated including washers and nuts.

.5 Paint pipe sleeves one (1) coat primer.

.6 Paint all relief and drain pipes serving Mechanical equipment, flat black.

1.17 **CUTTING & PATCHING**

.1 It is the responsibility of the Prime Mechanical Contractor to install sleeves for piping and ducts, and provide frames for opening for grilles, louvres, fans and similar equipment to be built into the existing building. All structural components must have the location, size and proposed method of cutting approved before proceeding.

.2 Should damage occur to the work of other trades and Divisions, remedial work will be done by the trade who originally installed the work, at the expense of the sub-contractor who caused the damage.

.3 Co-ordinate work with Section 07 84 00 - Firestopping.

1.18 **SLEEVES**

.1 Provide pipe sleeves at points where pipes (plumbing, heating, sprinkler, gas, etc.) pass through masonry of minimum 22 gauge thickness galvanized sheet steel with lock seam joints. Where ducts pass through masonry provide suitable 18 gauge galvanized steel sleeves. Size sleeves on insulated piping or ducts to permit insulation to continue through. Where piping or ducts pass through concrete or frame construction, provide 1/8" (3 mm) thick galvanized iron sleeves. On copper pipe provide copper pipe sleeves.

.2 Use cast iron or steel pipe sleeves with annular fin continuously welded at midpoint, through foundation walls and where sleeve extends above finished floor.

.3 Provide 1/8" (3 mm) clearance all around, between sleeve and pipes or between sleeve and insulation and where piping passes below footings, provide minimum clearance of 2" (50 mm) between sleeve and pipe. Backfill up to underside of footing with concrete of same strength as footing.

.4 Terminate sleeves flush with surface of concrete and masonry and 2" (50 mm) above floors. Not applicable to concrete floors on grade.

.5 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction; caulk between sleeve recess and pipe; fasten roof flashing to clamp device; make watertight durable joint.

.6 Fill voids around pipes.

.1 Where sleeves pass through walls or floors, caulk space between insulation and sleeve or between pipe and sleeve with waterproof, fire-retardant, non-hardening mastic. Seal space at each end of sleeve with waterproof, fire-retardant, non-hardening mastic.

.2 Ensure no contact between copper pipe and ferrous sleeve.

.7 Co-ordinate work with Section 07 84 00 - Firestopping.

1.19 **ESCUTCHEONS & PLATES**

.1 Provide on exposed pipes passing through finished walls, partitions, floor and ceilings.

.2 Use chrome or nickel-plated brass, solid type with set screws for ceiling or wall mounting.

.3 Inside diameter shall fit around finished pipe. Outside diameter shall cover sleeve.

.4 Where sleeve extends above finished floor, escutcheons or plates shall clear sleeve extension.

.5 Secure to pipe or finished surface.

1.20 **TESTING & ADJUSTING**

.1 Test all piping systems for leaks providing gauges, materials and labour as required. Equipment furnished as part of the permanent installation shall not be used for testing purposes. Before testing, remove all equipment which is not designed to withstand the test pressures. All piping is to be tested before covering is applied, and before backfilling or concealing.

.2 Hydrostatic Tests: All pressure pipe is to be tested as described in each Section. Test pressure shall be maintained for the times noted, during which time the pressure test shall remain constant without pumping.

.3 Gravity Piping: All gravity drainage piping shall be given a ball test and a water test, which must be supervised and inspected by the local Plumbing Inspector.

.4 All testing shall be done to the satisfaction and approval of the Consultant and the Prime Mechanical Contractor shall notify the Consultant forty-eight (48) hours prior to testing.

.5 Before final payment, test the operation of each system and all equipment installed, make all necessary adjustments and replacements, and demonstrate to the satisfaction of the Consultant that all equipment is operating as intended and without undue noise and vibration.

.6 All tests must be witnessed by the Owner's Authorized Representative. Failure to do so will result in a re-test.

.7 If system pumps are used during the system flushing, Prime Mechanical Contractor shall supply and install replacement pump seals in each pump, once flushing is complete and tests results accepted.

1.21 **START-UP & INSTRUCTION**

.1 The Prime Mechanical Contractor shall start-up equipment and operate for a minimum of five (5) days. During this time, adjust controls, clean strainers, replace faulty gauges and thermometers, fasten loose equipment and reduce noise.

1.22 **OPERATE & ADJUST SYSTEMS**

.1 Operate all systems to full capacity and verify proper, safe, efficient operation of all parts and each complete system. Oil motors and grease bearings before operating equipment.

.2 When work is complete and systems are in operation, adjust valves, belt drives, controls and thermostats so that there is an even distribution of cooling and heating throughout. Turn over to Owner necessary keys, handles and operating devices for each system.

.3 Test for both heating and cooling days. Refer to Section 23 05 93 - Testing, Adjusting and Balancing.

1.23 **COMPLETION**

.1 Keep the premises in a clean and orderly condition during construction. All waste and unusable materials shall be promptly removed from the site.

.2 Upon completion of this work, go over the entire installation, clean and polish all fixtures and equipment, and remove all surplus materials and rubbish of every description incidental to this work, leaving the installation neat and orderly.

.3 Before final payment is made, the following items must be completed:

.1 Present to the Consultant "Maintenance Manuals" complete with air and water balancing reports, wiring diagrams and certified equipment prints.

.2 Present to the Consultant an as-built record set of drawings and USB.

.3 Instruction of Owner's personnel in the maintenance and operation of all new equipment.

.4 Present to the Consultant Test Certificates and results.

.5 Present to the Consultant Valve Tag Charts.

.6 Spare filters and frames, labelled and located where directed by the Owner.

.7 Present to the Consultant start-up report for chiller.

.8 Present to the Consultant start-up report for heating boilers.

.9 Present to the Consultant start-up report for domestic water boilers.

.10 Present to the Consultant start-up report for all ductless split air conditioning systems.

.11 Present to the Consultant complete controls commissioning report.

.12 Present to the Consultant Sprinkler system as-built drawings and hydraulic calculations.

.13 Present to the Consultant as-built drawings on CAD diskette.

.14 Present to the Consultant start-up report for refrigerant detector and alarm system.

.15 Submit water treatment report for heating water systems.

.16 Submit Start-up Reports for all HVAC equipment including, but not limited to:

.1 Boilers

.2 Hot Water Heaters

.3 Energy Recovery Ventilators

.4 Heat Recovery Units

.5 Air Handling Units

.17 Maintain a set of approved drawings on site available for review by authorities.

.18 Perform the above work in a timely manner so as not to interfere with the progress of the project.

.19 A value of 3% of the total contract price shall be withheld until points .1 to .18 are completed to the satisfaction of the Consultant.

1.24 **PROTECTION**

.1 Protect work from damage. Securely plug or cap open ends of conduits, pipes, ducts or equipment to prevent entry of dirt, dust, debris, water, snow or ice. Cover all items cast into concrete floors/walls such as floor drains, cleanouts, etc., prior to pour, with heavy plastic tape or duct tape. Clean all piping, ducting, conduits and equipment inside and outside before testing.

.2 Material stored on site shall be protected from weather and kept dry and clean at all times. Take care to avoid corrosion of metal parts. Protect all bearings and motors from damage due to moisture and dust. Equipment not yet in operation shall be turned over at least at monthly intervals to prevent bearing deterioration.

1.25 **TEMPORARY OR TRIAL USAGE**

.1 Do not use any permanent Mechanical Systems during construction unless specific written approval is obtained from the Consultant.

.2 Temporary or trial usage of any mechanical device, machinery, apparatus, equipment or materials shall not be construed as evidence of acceptance of same and no claim for damage shall be made for injury to or breaking of any part of such work which may so be used.

.3 Where the Owner permits the use of a system the Prime Mechanical Contractor shall be in charge of and maintain all equipment in accordance with manufacturers instruction at all times the systems are in operation.

.4 The use of permanent systems shall not invalidate the guarantee or warranty.

.5 Prior to final acceptance, return all equipment to as new condition and provide supplier certification of same.

1.26 **LIABILITY**

.1 Each Section and Trade shall:

.1 Assume full responsibility for laying out his work and for any damage caused to other Sections or Owner by improper location or carrying out of same.

.2 Be responsible for prompt installation of work in advance of concrete pouring, ceiling installation or similar work.

.3 Protect finished and unfinished work of the Mechanical Divisions and work of other Sections from damage due to work of Mechanical Divisions.

.4 Be responsible for condition of material and equipment supplied. Be responsible for protection and maintenance of work completed until termination and acceptance.

1.27 **DIELECTRIC COUPLINGS**

.1 Provide wherever pipes of dissimilar metals are joined.

.2 Provide insulating unions for pipe sizes 2"Ø (50 mm) and smaller, and flanges for pipe sizes 2-1/2" (65 mm) and larger. Brass adaptors and bronze valves will not be accepted.

.3 Provide an isolating separation wherever piping may touch dissimilar metal studs, joists, concrete, etc.

1.28 **PERMITS & FEES**

.1 Pay all permit and inspection fees in order to complete the work contained in Divisions 21, 22, 23 and 25.

1.29 **RIGGING OF EQUIPMENT**

.1 Provide all rigging, hoisting and handling of equipment as necessary in order to place the equipment in the designated area in the building.

.2 Direct this work by qualified people normally engaged in rigging, hoisting and handling of equipment.

1.30 **RIGHTS RESERVED**

.1 Rights are reserved to furnish any additional detail drawings which, in the judgement of the Consultant, may be necessary to clarify the Work and such drawings shall form a part of the Contract.

1.31 **SUPERINTENDENCE**

.1 Maintain at this job site, at all times, qualified personnel and supporting staff with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.

1.32 **CO-ORDINATION**

.1 The Prime Mechanical Contractor is responsible for co-ordinating the mechanical work herein to suit Project Phasing Schedule.

.2 Co-ordinate all Mechanical Work with the work of any other Divisions to avoid conflicts. Be responsible for modifying the work of the Mechanical Divisions to accommodate space conflicts.

.3 Failure to co-ordinate will result in installed work being removed and new work put in place without cost to the Owner.

.4 Refer to the Architectural Specification for project phasing plans and description.

1.33 **FIRE STOPPING**

.1 The Prime Mechanical Contractor is responsible for all fire stopping related to the work of Division 21, 22 and 23 including, but not limited to, the ductwork, piping and control wiring. Fire stopping shall be in accordance with Section 07 84 00 - Firestopping.

1.34 **PROJECT CO-ORDINATION/PHASING OF THE WORK**

.1 The Prime Mechanical Contractor shall refer to the Architectural Drawings and Specifications for co-ordination requirements and completion dates for various portions of the Project.

.2 Refer to Section 01 11 00 of the Architectural Specification for Construction Phasing information.

1.35 **MOVING, HOISTING & SCAFFOLDING**

.1 The prime mechanical contractor is responsible for moving, hoisting and demurrage for all equipment and materials to be furnished and installed under the Mechanical Divisions. Include for the cost of dismantling and reassembling equipment, where required, to the manufacturer's approval.

1.36 **TIME FOR COMPLETION**

.1 Review the general contract requirement for completion dates. Identify at the time of tender any items which may affect the time for completion.

.1 Advise the Consultant if materials and equipment involves longer delivery times than indicated in the schedule.

.2 Monitor and expedite delivery of equipment and materials. If necessary, inspect at source of manufacture.

.3 Be responsible for failure of, or delay in, the delivery of specified equipment.

1.37 **IMPELLER, SHEAVE & BELT CHANGES**

.1 The Prime Mechanical Contractor to carry the costs to supply and install pump impeller, fan sheave and belt changes. See Section 23 05 93 - Testing, Adjusting and Balancing.

1.38 **COMMISSIONING**

.1 The Owner has retained a Commissioning Agent to provide commissioning services for Mechanical equipment and systems.

1.39 **SEISMIC BRACING (MECHANICAL SYSTEMS)**

.1 All mechanical systems shall be installed to comply with the requirements of the Ontario Building Code, Paragraph 4.1.8.18 and Table 4.1.8.18.

.2 Provide seismic bracing for all mechanical systems to meet the requirements of Table 4.1.8.18.

.3 For the purposes of calculating seismic forces, the following is to be used:
Fv = 1.44632
Fa = 1.1428
Ie = 1.0
Sa(0.2) = 0.319
IE (Importance Factor) = 1.0
IeFaSa (0.22) = 0.36
Site Class D

.4 Provide flexible pipe and duct connections at the inlet and outlet connections for mechanical equipment as required.

.5 For all floor mounted equipment, provide lateral seismic resistance.

.6 Prime Mechanical Contractor shall retain a Professional Structural Engineer and/or a qualified Company specializing in seismic constraints to design, supply and install seismic bracing as required. Engineer/Company shall review the installation of seismic support for all mechanical equipment and provide documentation (Drawings, calculations and details) to the Consultant which states that the installation complies with the requirements of Ontario Building Code 4.1.8.18. Reports to be issued by a Structural Engineer licensed in Ontario.

.7 Prime Mechanical Contractor to provide Supplier Shop Drawings of all mechanical equipment and co-ordinate fully with seismic restraint installation.

.8 Acceptable Products:

.1 Vibro Acoustics

.2 E.H. Price

.3 Kinetic Noise Control

1.40 **LOCAL UTILITIES**

.1 The Prime Mechanical Contractor, before tendering, to contact all utilities to determine the local procedures and policies concerning services, and portions of that service which would be supplied or available through the utilities and incur any cost. The Prime Mechanical Contractor to ensure no delays in construction or service connections.

1.41 **CO-OPERATION OF TRADES**

.1 The Prime Mechanical Contractor is to co-operate with all other trades on the job so that all equipment can be satisfactorily installed, and so that no delay is caused to any other trade. Any reworking of installed equipment, piping, or ducting to accommodate the installation of other trades Work shall be performed at no extra cost.

1.42 **CHARGES FOR EXTRAS & CREDITS**

.1 Extras and credits for Mechanical Contractors and Subcontractors shall be charged on the following basis:

.1 Materials - trade price[1] plus overhead plus profit as outlined in the General Conditions.

.2 Labour - Journeyman's and foreman's labour at current local union rates plus workplace safety & insurance fees plus unemployment insurance plus overhead plus profit as outlined in the General Conditions.

.3 Labour hour charges shall be within 10% of the unit prices in the National Labour Calculator.

.2 Credits shall be the same as above, except no overhead and profit.

.3 Disputes shall be settled by arbitration.

.4 All submittals must include a detailed breakdown showing lengths, sizes, quantities of materials, unit labour charges with labour rates, mark ups, overhead and profits with totals. Submittals that do not include a detailed breakdown cannot be reviewed.

1.43 **STORAGE & PROTECTION OF MATERIALS**

.1 Proper facilities for storage and protection of materials and equipment are to be provided at the job site by the Prime Mechanical Contractor.

.2 All pipe to be used on the job to be carefully stacked off the floor with ends capped or suitably plugged to prevent the entry of dirt and debris until such time the piping is being installed. Similarly all openings in pressure vessels, tanks, etc., to be kept closed until ready for use. Any piping not suitably protected to be removed from the site and replaced with new.

.3 Equipment located on site must also be suitably protected to prevent damage from abuse or misuse. Protect all bearings and motors from damage due to moisture and dust. Equipment not yet in operation shall be turned over at least monthly to prevent bearing deterioration. Equipment and/or materials damaged after delivery to site is to be replaced or repaired to the satisfaction of the Consultant.

.4 Make known any hazardous or flammable materials to be used and method of application, before using. The Prime Mechanical Contractor shall be responsible for proper storage and all necessary safety requirements in the storage and use of all hazardous and flammable materials used in the execution of their Work.

1 Trade price means the price at which the Contractor or his Subcontractor pays for the materials including all discounts.

1.44 **DELIVERY**

.1 Transport and handle the material in conformance with the Manufacturers instructions.

.2 Deliver the materials to the job site in their original packaging. The name and address of the manufacturer must be labelled on the packaging.

.3 Packing Waste Management: Recover the packaging waste so that it may be reused, recycled or reclaimed by the Manufacturer. This includes, but is not limited to, pallets, packing, and other packing material.

1.45 **PLACING IN OPERATION**

.1 Upon completion of the Work and before turning over the job, the Contractor is to make a complete test of the various systems.

.2 Flush and sterilize domestic water mains in accordance with the procedures established by AWWA Specification C601.

.3 Flush all other domestic water piping in accordance with Local and Provincial Codes.

1.46 **PIPE GRADING**

.1 Piping: Heating water piping is to run level. Domestic water piping is to grade to low points. Branch piping to heating units below the main shall be off the bottom, and off the top to units above.

.2 Condensate piping to be graded down in direction of flow 1" in 20'-0" (25 mm in 6,000 mm).

.3 Equipment drain piping to be graded down in the direction of flow 1" in 4'-0" (25 mm in 1,200 mm).

1.47 **EQUIPMENT DRAINS**

.1 Supply and install drain piping from all relief valves, and backflow preventers. Piping to be installed to spill into hub drains or funnel floor drains. Provide traps as required.

1.48 **EXCAVATION, TRENCHING, BACKFILLING & BEDDING (INDOORS)**

.1 This Division shall do all excavation, trenching, backfilling and bedding in connection with this Work. Refer to the soil reports for details on rock relief, water table and soil material. Excavation is to be based on soil with random pieces up to 12" (300 mm) diameter. Foundations, large concrete pieces, slabs, rock layers and unstable soils that are not shown on the Drawings or soils reports will be treated as a site condition. Blasting is not permitted, except by permission of the Consultant. Rock material is to be broken by a hydraulic ram. All trenching and excavation shall be done in strict accordance with the Occupational Health and Safety Act latest revision thereof.

.2 All excavations shall be protected with fencing, timber sheeting, bracing or shoring as required.

.3 Remove all timber and protective devices before backfilling or when the necessity of protection ceases. Keep excavated areas free of water by providing pumps, hoses, strainer, other appurtenances, power, labour and maintenance as required. All piping and equipment shall be tested, inspected and approved before backfilling.

.4 All piping and equipment shall have adequate bedding. Trenches shall be excavated 6" (150 mm) below the intended grade of the piping. The pipe bedding granular 'A' of which at least 50% will pass a 1/4" (8 mm) sieve and 100% will pass a 1/2" (15 mm) sieve, backfilled by hand from the centre line of the pipe to 6" (150 mm) above up to 18" (450 mm) diameter, and 12" (300 mm) above for larger diameter pipes. Compact in 6" (150 mm) layers by tamping. The subgrade beneath the pipe shall be within .03 ft. (9 mm) of a straight line between joints. Bell holes shall be made at each joint to permit the joint to be properly made. Debris is to be kept out of the piping. No backfill is permitted until the test is witnessed. Bedding shall be compacted to 95% modified Proctor test.

.5 Backfill shall be non-cohesive ballast material of which at least 50% will pass a 1/4" (8 mm) sieve and 100% will pass a 1/2" (15 mm) sieve. The backfill shall be placed in layers not exceeding 12" (300 mm) loose measurement.

.6 Compaction of the backfilled material shall be to 95% Proctor density. Where Proctor tests are called for, these will be paid for out of the allowance in Division 2. Proctor tests as a result of re-testing shall be paid for by this Division. Protect the pipe during backfilling and compaction so that damage or a movement of the pipe is avoided. The pipe must be protected with a minimum of 20" (500 mm) of compacted cover before backfill by mechanical means.

.7 The backfill shall be compacted by mechanical hand compaction equipment to achieve the specified density. Water may be used as an aid to compaction, but not as the sole means of compaction. Backfilling shall not be done in freezing weather, except by permission of the Consultant.

.8 Carefully backfill both sides of piping and equipment simultaneously to prevent movement or displacement. All excess materials shall be removed from the premises as directed and legally disposed of by this Division. In no case shall piping be installed over backfill. Special supports, bridges etc. are to be provided.

.9 Refer to latest Geotechnical Report for additional information regarding bedding and backfill requirements.

1.49 **DRAIN VALVES**

.1 Supply and install 3/4" (20 mm) ball valve and hose end at main low points to drain each water type system, at pumps, coils, strainers and at each piece of equipment.

1.50 **ELECTRICAL MOTORS**

.1 Unless otherwise specified motors shall be squirrel cage induction type with standard drip proof enclosure.

.2 Motors unless otherwise specified shall meet all requirements of EEMAC and CSA standards for electrical motors and where possible shall be of Canadian Manufacturer.

.3 Generally, all motors shall have starting current-torque characteristics in accordance with EEMAC, Design 8 unless otherwise specified or unless load characteristics require a higher starting torque. Each motor shall have sufficient starting torque to start the driven equipment and to accelerate it to full speed within 10 seconds. Motor horsepower's shown are minimums. Submit starting times for review.

.4 All motors shall be nominal 1750 rpm, unless otherwise specified.

.5 Unless noted otherwise, all motors shall have Class 8 insulation and shall be designed for continuous operation at 40 deg. C. (deg. F.) Motors controlled from variable speed drives shall have Class H windings and Class F insulation.

.6 Motor connection boxes shall be located on side of motor most easily accessible for maintenance and remote from belts, gears or driven equipment. If boxes are factory installed on wrong side of motor they shall be relocated.

.7 Each multi-speed motor and associated switching device shall be circuited such that the overload device in the starter protects the motor on each step of the multi-speed switch. As an alternative to this requirement, the motor may have integral overload protection. Multi-speed motors shall be single winding variable torque for 50% motor speed reduction and double winding, two speed for all other speed reductions.

.8 Motors shall have the following electrical characteristics:

.1 For 0.375 kW (1/2 HP) and larger 600 Volt, 3 phase, 60 cycle

.2 For 0.25 kW (1/3 HP) and smaller 120 Volt, 1 phase, 60 cycle

.3 Single phase motors 0.25 kW (1/3 HP) and smaller shall be capacitor start.

.9 All motors 22.4 kW (30 HP) and larger shall have heat detector protection embedded in the windings for connection into the motor control circuit. Protection shall be Siemens thermistor.

.10 Motor enclosures shall be as follows:

.1 If protected from the weather and entraining moisture, use open drip-proof, service factor 1.15.

.2 Motors located in air streams shall be selected to operate satisfactorily at maximum temperature and moisture levels of surrounding air.

.3 For all other locations, use totally-enclosed fan-cooled, service factor 1.0.

.11 Use explosion proof motors where scheduled.

.12 High efficiency motors shall be T frame, A.C., three phase, meet or exceed the Ontario Hydro Enermark Motor Efficiency Levels as tested to either CSA 390M or IEEE-1128, meet or exceed ASHRAE Standard 90.1 (latest edition) motor high efficiency level and be approved under the Canadian Electrical Safety Code:

.13 High efficiency motors shall be used on all fans and pumps having motors 0.75 kW (1 HP) or larger.

.14 Each electric motor shall be complete with a lamacoid nameplate securely fastened in a conspicuous place on the motor. The nameplate shall be a minimum of 2 mm (3/32") thick laminated phenolic plastic 100 mm (4") long x 50 mm (2") wide with black face and white centre, 5 mm (7/32") high letters shall be engraved through to the white lamination with the following:

.1 Motor No.

.2 Mechanical Equipment Driven

.3 Circuit No.

.4 Panel No.

.5 Panel Location

.15 Electric motors shall be manufactured by Canadian General Electric, Westinghouse, Lincoln, U.S. Motors, Baldor or Weg.

Part 2 - Products

2.1 **MATERIALS & EQUIPMENT - APPROVED EQUALS, BASIS OF DESIGN, BASE BID, APPROVED ALTERNATES, UNSOLICITED ALTERNATES.**

.1 Provide material and equipment in accordance with Division 01.

.2 Material and equipment to be CSA certified. Where CSA certified material and equipment is are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.

.3 Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Inspection Department.

.4 Factory assemble control panels and component assemblies.

.5 The Specification indicates Approved Equal manufacturers (or Approved Manufacturers) for various Products, materials and systems which make up the electrical Work. The Contract Price shall be based on any of the "Approved Equals".

.6 The Specifications may also indicate Base Bid and Approved Alternate manufacturers for various Products, materials and systems. For such cases, the Contract Price **MUST** be based on the "Base Bid" manufacturer/system. The net dollar addition or deduction to/from the Contract Price for each "Approved Alternate" shall be indicated on a separate form or letter attached to the Bid Form for consideration by the Consultant.

.7 Basis of Design:

.1 The Specifications may also indicate a Basis of Design manufacturer/model or system. For such cases, the specification is based on the product, equipment and/or system of the Manufacturer so named in the Specification.

.2 Products, equipment and/or systems proposed by the Approved Equal manufacturers and Suppliers named in the Specifications shall be acceptable, provided all functions and operations are provided as specified.

.3 Other products and/or systems shall also be accepted provided they are; equal in aesthetic (i.e. share the same geometric form), are of the same material, are manufactured to the same level of quality, provide equal or better performance and are offered with the same accessories and finish options as specified for the Basis of Design product/system.

.4 The Owner and Consultant reserve the right to request alternatives for any product/system submittals that do not share the same qualities, as noted above, as those of the Basis of Design product/system listed, at no additional cost to the Owner.

.8 Unsolicited Alternate manufacturer/systems which do not appear in the Contract Documents may also be proposed, provided the following conditions are met:

.1 They appear separately in an accompanying letter attached to the Bid Form.

.2 The net dollar deduction from the Contract Price if the alternate is accepted. This value shall reflect all costs associated with the incorporation of the alternate into the Work, including any required changes in Architectural, Structural, Mechanical and other Electrical Sections as well as the Consultants costs of revising their designs and documents to suit.

.9 Unsolicited Alternate manufacturer/systems proposed during construction due to apparent long lead times and/or delivery issues shall be rejected.

.10 The Owner reserves the right to accept or reject any or all "Approved Alternates" or "Unsolicited Alternate" manufacturers/systems.

Part 3 - Execution

3.1 **PAINTING REPAIRS & RESTORATION**

.1 Prime and touch up marred finished paintwork to match original.

.2 Restore to new condition, finishes which have been damaged.

3.2 **CLEANING**

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.3 **DEMONSTRATION**

.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.

3.4 **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 Pipe, fittings, valves, and connections for sprinkler systems.

1.2 RELATED SECTIONS

.1 Section 09 91 22 - Painting: Preparation and painting of fire protection piping systems.

.2 Section 21 13 00 - Sprinklers: Sprinkler system design.

.3 Section 23 05 53 - Mechanical Identification: Piping identification.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.

.4 ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

.5 CSA (Canadian Standards Association).

.6 NFPA 13 - Standard for the Installation of Sprinkler Systems.

.7 UL 405 - Standard for Fire Department Connection Devices

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings.

.3 Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.5 CLOSEOUT SUBMITTALS

.1 Record Documentation: Record actual locations of components and tag numbering.

.2 Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.6 REGULATORY REQUIREMENTS

.1 Sprinkler Systems: Conform work to NFPA 13.

.2 Valves: Bear ULC label or marking. Provide manufacturer's name and pressure rating marked on valve body.

.3 Products Requiring Electrical Connection: Listed and classified by CSA as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, & PROTECTION

.1 Transport, handle, store, and protect products.

.2 Deliver and store valves in shipping containers, with labelling in place.

.3 Provide temporary protective coating on cast iron and steel valves.

.4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

Part 2 - Products

2.1 **ABOVE GROUND PIPING**

.1 Steel Pipe: ASTM A53/A53M, UL listed, threadable, light wall ASTM A795/A795M ASME B36.10M; Schedule 40, black galvanized.

.1 Steel Fittings: ASME B16.9, wrought steel, buttwelded ASME B16.25, buttweld ends ASTM A234/A234M, wrought carbon steel and alloy steel ASME B16.5, steel flanges and fittings ASME B16.11, forged steel socket welded and threaded.

.2 Cast Iron Fittings: ASME B16.1, flanges and flanged fittings ASME B16.4, threaded fittings.

.3 Malleable Iron Fittings: ASME B16.3, threaded fittings ASTM A47/A47M.

.4 Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, C-shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

.5 Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

2.2 **PIPE HANGERS & SUPPORTS**

.1 Conform to NFPA 13.

.2 Hangers for Pipe Sizes 13 to 38 mm (1/2 to 1-1/2 inch): Malleable iron or Carbon steel, adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 50 mm (2 inches) and Over: Carbon steel, adjustable, clevis.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.5 Wall Support for Pipe Sizes to 75 mm (3 inches): Cast iron hook.

.6 Wall Support for Pipe Sizes 100 mm (4 inches) and Over: Welded steel bracket and wrought steel clamp.

.7 Vertical Support: Angle ring or Steel riser clamp.

.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.3 **GATE VALVES**

.1 Up to and including 50 mm (2 inches): Bronze body, bronze trim, rising stem, handwheel, solid wedge or disc, threaded ends.

.2 Over 50 mm (2 inches): Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, handwheel, OS&Y, solid rubber covered bronze or cast iron wedge, flanged or grooved ends.

.3 Over 100 mm (4 inches): Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends, iron body indicator post assembly.

2.4 **GLOBE VALVES**

.1 Up to and including 50 mm (2 inches): Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable rubber disc, threaded ends, with backseating capacity repackable under pressure.

.2 Over 50 mm (2 inches): Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.5 **ANGLE VALVES**

.1 Up to and including 50 mm (2 inches): Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable rubber disc, threaded ends, with backseating capacity repackable under pressure.

.2 Over 50 mm (2 inches): Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.6 **BALL VALVES**

.1 Up to and including 50 mm (2 inches): Bronze Stainless steel two-piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle and balancing stops, threaded ends with union.

.2 Over 50 mm (2 inches): Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle or gear drive handwheel for sizes 250 mm (10 inches) and over, flanged.

2.7 **BUTTERFLY VALVES**

.1 Bronze Body: Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, handwheel and gear drive and integral indicating device. Built-in tamper proof switch rated 10 Amp at 115 Volt DC.

.2 Cast or Ductile Iron Body: Cast or ductile iron, chrome or nickel plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck, handwheel and gear drive and integral indicating device and internal or external tamper switch rated 10 Amp at 115 Volt AC.

2.8 **CHECK VALVES**

.1 Up to and including 50 mm (2 inches): Bronze body and swing disc, rubber seat, threaded ends.

.2 Over 50 mm (2 inches): Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends with automatic ball check.

.3 100 mm (4 inches) and Over: Iron body, bronze disc, stainless steel spring, resilient seal, threaded, wafer, or flanged ends.

2.9 **DRAIN VALVES**

.1 Compression Stop: Bronze with hose thread nipple and cap.

.2 Ball Valve: Brass with cap and chain, 20 mm (3/4 inch) hose thread.

Part 3 - Execution

3.1 **PREPARATION**

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

.2 Remove scale and foreign material, from inside and outside, before assembly.

.3 Prepare piping connections to equipment with flanges or unions.

3.2 **INSTALLATION**

.1 Install piping to NFPA 13 for sprinkler systems.

.2 Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

.3 Install piping to conserve building space, to not interfere with use of space and other work.

.4 Group piping whenever practical at common elevations.

.5 Sleeve pipes passing through partitions, walls, and floors.

.6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

.7 Inserts:

.1 Provide inserts for placement in concrete formwork.

.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm (4 inches).

.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.

.8 Pipe Hangers and Supports:

.1 Install to NFPA 13.

.2 Install hangers to provide minimum 13 mm (1/2 inch) space between finished covering and adjacent work.

.3 Place hangers within 300 mm (12 inches) of each horizontal elbow.

.4 Use hangers with 38 mm (1-1/2 inch) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

.5 Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

.6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.7 Provide copper plated hangers and supports for copper piping sheet lead packing between hanger or support and piping.

.9 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

.10 Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

.11 Do not penetrate building structural members unless indicated.

.12 Provide sleeves when penetrating floors walls footings. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.

.13 When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

.14 Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

.15 Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to after installation.

.16 Provide gate ball butterfly valves for shut-off or isolating service.

.17 Provide drain valves at main shut-off valves, low points of piping and apparatus.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Fire Extinguishers.

1.2 RELATED REQUIREMENTS

.1 Section 21 11 00 - Fire Protection Piping.

.2 Section 21 13 00 - Sprinklers.

.3 Section 23 05 53 - Mechanical Identification.

.4 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Division 01: Project management and coordination procedures.

1.5 ACTION SUBMITTALS

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide manufacturer's catalogue sheet for equipment indicating rough-in size, finish, and accessories.

.3 Shop Drawings: Indicate supports, components, accessories, and sizes. Submit Shop Drawings and Product data to Owner's insurance underwriter for approval. Submit proof of approval to Consultant. Submit stamped Drawings to local authority per Sprinkler Drawings

1.6 CLOSEOUT SUBMITTALS

.1 Operation Data: Include manufacturer's data.

.2 Maintenance Data: Include servicing requirements and test schedule.

.3 Record Documentation: Record actual locations of components.

1.7 MAINTENANCE MATERIAL SUBMITTALS

.1 Maintenance and extra material requirements.

.2 Extra Stock Materials: Provide [two (2)] of hose nozzles and hoses.

1.8 QUALITY ASSURANCE

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and approved by the manufacturer.

.3 Certificates: Provide certificate of compliance from authority having jurisdiction indicating approval of field acceptance tests.

1.9 **DELIVERY, STORAGE, & HANDLING**

.1 Transport, handle, store, and protect Products.

.2 Deliver and store products in shipping packaging until installation.

Part 2 - Products

2.1 **FIRE EXTINGUISHERS**

.1 Provide where identified, 5 lb. (2.27 kg) extinguishers with a rating of 3A-10BC complete with a wall bracket for exposed installations.

.1 Designated FE

.2 Provide where identified, 10 lb. (4.54 kg) extinguishers with a rating of 6A-80BC complete with a wall bracket for exposed installations.

.1 Designated FE-1

.3 Mechanical and Shop extinguishers shall be ABC-10F extinguisher with 4A-60 BC rating. Provide wall bracket and fasten securely to wall.

.1 Designated FE-2

.4 Kitchen fire extinguishers shall be potassium carbonate type with Class K, 6 litre, 1A:K rating. Mount on wall bracket.

.1 Designated FE-3

.5 Electrical Room and Transformer Room fire extinguishers shall be dry chemical type with 40 BC rating, Model PKD-10F, 10 lb., 60 BC. Mount on wall bracket.

.1 Designated FE-4

.6 Boiler Room fire extinguishers shall be dry chemical type with 40 BC rating, Model PKD-10F, 10 lb., 60 BC. Mount on wall bracket.

.1 Designated FE-5

.7 Computer equipment rooms shall have carbon dioxide Model CD-5, 5 BC rating fire extinguishers with wall bracket.

.1 Designated HFE.

.8 Acceptable Manufacturers:

.1 Impaction Fire Equipment Ltd.
.2 Chubb Fire Security
.3 National Fire Equipment
.4 Wilson & Cousins
.5 Williams Brothers

Part 3 - Execution

3.1 **INSTALLATION - FIRE EXTINGUISHERS & CABINETS**

.1 Extinguishers:

.1 Install units where shown, fully charged and free of any defects.
.2 Install the extinguishers immediately prior to Substantial Performance inspection and be responsible for their security until the building has been accepted.

.2 Cabinets:

.1 Turn over cabinets to the block layer for installation within block walls, fasten to framing Provided by others in metal stud partitions. Mount flush with wall.

.2 Mount cabinets 5'-0" (1500 mm) above finished floor to top of cabinet.

.3 Wall Hangers: Mount hangers securely to wall so that top of extinguisher is 5'-0" (1500 mm) above finished floor.

.4 General: Comply with the requirements of the National Fire Protection Association (NFPA 10), the Ontario Building Code (OBC) and the Ontario Fire Code.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Wet-pipe sprinkler assembly.

.2 System design, installation, and certification.

.3 Fire department connections.

1.2 RELATED SECTIONS

.1 Section 31 00 00 - Earthwork.

.2 Section 21 12 00 - Fire Protection Piping

.3 Section 23 05 53 - Mechanical Identification.

.4 Section 23 05 48 - Vibration Isolation.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 CSA (Canadian Standards Association).

.4 NFPA 13 - Standard for the Installation of Sprinkler Systems.

1.4 SYSTEM DESCRIPTION

.1 System to provide coverage for entire building.

.2 Provide system to NFPA 13 to the following occupancies:

.1 All areas not listed: Light Hazard

.2 Kitchen, Store Rooms, Mechanical Rooms: ordinary hazard, Group 2

.3 Provide fire department connections where indicated on the Drawings.

.4 Provide window sprinkler systems where indicated on the Drawings.

.5 Provide all sprinkler heads, piping, supervised valves and flow switches, flow tests etc., for a complete and operating system, all to NFPA-13, latest edition. All equipment to be ULC listed.

.6 All sprinkler heads, piping to be located to suit structural conditions, electrical and mechanical work. Contractor is to co-ordinate with other trades before installation.

.7 Contractor to co-ordinate location and type of equipment to be wired by Division 26 so that fire alarm panels and wiring may be completed without extras to the Contract.

.8 Pay all fees as required for flow tests and plans examinations.

.9 The Sprinkler Contractor may wish to propose alternate arrangements and equipment to that shown. All proposed alternates must be listed on the Tender form showing the price saving. Do not proceed until notified in writing that the saving has been accepted.

.10 Provide REVIT Compatible disk to Consultant indicating sprinkler system plans, including all as-built revisions.

1.5 **ADMINISTRATIVE REQUIREMENTS**

.1 Division 01: Project management and coordination procedures.

.2 Pre-installation Meetings: Convene one (1) week before starting work of this section.

1.6 **REQUIREMENTS OF REGULATORY AGENCIES**

.1 Performance of work under this Section shall be in accordance with Local or District By-Laws and Regulations and the approval of the following:

.1 Fire Department

.2 Building Department

.3 Owner's Insurance Company

1.7 **SUBMITTALS**

.1 Before commencing with the Sprinkler System installation, this Division shall submit Engineer-stamped 1/8" (1:100) scale working plans with 1/4" (1:50) sections and details and stamped copies of hydraulic calculations stamped "Reviewed by the Authorities and/or agencies having jurisdiction over the installation for approval." Submit to the Architect and Consultant for review, approved and stamped drawings before commencing installation. Any comments received from the Owners service agent shall be reviewed by the Consultant. Consultant to advise whether comments are to be incorporated into the drawings.

.2 Provide letter from Electrical Contractor confirming co-ordination of wiring for all equipment and devices.

.3 Shop drawings will be required for the following items:

.1 Sprinkler heads - each type

.2 Alarm valve and trim - each type, i.e. press switches, accelerators, etc.

.3 Siamese connections

.4 Flow switches

.5 Signage

.6 Double check valve backflow preventer assembly

1.8 **DESIGN CRITERIA**

.1 The piping system shown on the drawings shall be used as a guide for bidding purposes only, and for location of sprinkler heads, zoning and equipment locations.

.2 The systems shall be hydraulically calculated, designed and submitted to approving agencies by the trade responsible for the installation. Occupancies for the various areas are shown on the drawings. Schedule systems conforming to NFPA-13, and Authority having jurisdiction are acceptable.

.3 For the purposes of the Tender, the sprinkler system shall be sized based on the enclosed hydrant flow test water pressure at the end of this Section.

.4 System shall be designed with a minimum 5 psig safety factor to allow for future pressure reductions.

.5 Sprinkler System Occupancies (LH = Light Hazard; OH = Ordinary Hazard):

.1 All areas not listed - LH

.2 Kitchen - OH Group II

.3 Storage Rooms - OH Group II

.4 Mechanical Rooms - OH Group II

1.9 **ITEMS NOT INCLUDED (AS PER PLANS & SPECIFICATION FOR CLARIFICATION ONLY)**

.1 All underground fire mains

.2 All electrical power, alarm and supervisory wiring

.3 All electric heat tracing and pipe insulation

.4 All painting of sprinkler pipe, fittings and hangers

1.10 **CLOSEOUT SUBMITTALS**

.1 Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

.2 Record Documentation: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

.3 Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.11 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials:

.1 Provide sprinkler cabinet with twelve (12) extra sprinkler heads.

.2 Provide metal storage cabinet in Level 0 Mechanical Room.

.2 Tools: Provide suitable wrenches for each sprinkler type.

1.12 **QUALITY ASSURANCE**

.1 Perform Work to NFPA 13. Maintain one (1) copy of document on site.

.2 Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the place where the Project is located.

1.13 **REGULATORY REQUIREMENTS**

.1 Conform to ULC.

.2 Perform Work to NFPA 13.

.3 Equipment and Components: Bear ULC label or marking.

.4 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.14 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

Part 2 - Products

2.1 **SPRINKLERS**

.1 Include in the Contract for the supply and installation of an additional thirty (30) sprinkler heads complete with 100'-0" (30 meters) of 1" (25 mm) diameter piping to be used as required to suit final reflected ceiling layouts.

.2 Suspended Ceiling: Concealed pendant type with matching screw on escutcheon plate

.1 Manufacturers:

.1 Reliable
.2 Globe
.3 Grinnell
.4 Central
.5 Victaulic

.2 Finish: Chrome plated Brass Enamel, colour as selected.

.3 Escutcheon Plate Finish: Brass, Chrome plated, Enamel, colour as selected.

.4 Fusible Link: Fusible solder link type or Glass bulb type temperature rated for specific area hazard.

.3 Exposed Area Type: Standard upright type with guard.

.1 Manufacturers:

.1 Reliable
.2 Globe
.3 Grinnell
.4 Central
.5 Victaulic

.2 Finish: Brass, Chrome plated, Enamel, colour as selected.

.3 Fusible Link: Fusible solder link type or Glass bulb type temperature rated for specific area hazard.

.4 Sidewall Type: Standard, Recessed or Semi-recessed horizontal sidewall type with matching screw on escutcheon plate and guard.

.1 Manufacturers:

.1 Reliable
.2 Globe
.3 Grinnell
.4 Central
.5 Victaulic

.2 Finish: Chrome plated, Brass, Enamel, colour as selected.

.3 Escutcheon Plate Finish: Brass, Chrome plated, Enamel, colour as selected.

.4 Fusible Link: Fusible solder link type or Glass bulb type temperature rated for specific area hazard.

.5 Cold Areas: Quick response dry horizontal sidewall sprinkler head equal to Victaulic Style VS1, Model 3510 complete with chrome finish, to be connected to wet system.

.1 Manufacturers:

.1 Reliable
.2 Globe
.3 Grinnell
.4 Central
.5 Victaulic

.2 Finish: Chrome plated.

.3 Escutcheon Plate Finish: Chrome plated.

.4 Fusible Link: Fusible solder link type or Glass bulb type temperature rated for specific area hazard.

2.2 **PIPING SPECIALTIES**

.1 Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with pressure retard chamber and variable pressure trim; with test and drain valve.

.2 Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy chrome plated red enameled gong and motor housing, nylon bearings, and inlet strainer.

.3 Electric Alarm: Electrically operated chrome plated red enameled gong with pressure alarm switch.

.4 Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 Amp at 125 Volt AC and 2.5 Amp at 24 Volt DC.

.5 Fire Department Connections: Flush mounted wall type.

.1 Outlets: Two-way with thread size to suit fire department hardware; threaded dust cap and chain of matching material and finish.

.2 Drain: 19 mm (3/4 inch) automatic drip, outside.

.3 Label: SPRINKLER - FIRE DEPARTMENT CONNECTION.

.6 Supervisory Switches: ULC approved complete with two (2) sets of contacts.

2.3 **SIAMESE CONNECTIONS**

.1 Siamese connections shall be National Fire Equipment Limited Model 229 double clapper, chrome plated with caps, heavy duty chains and ball drip. Wall plate to read "Auto Sprinkler Fire Department Connection". Threads to be to local Region standards. See Drawings for location.

2.4 **ALARM CHECK VALVE**

.1 Alarm check valve shall be equal to Viking models as required for wet systems complete with low pressure and alarm switches, drain connection and pressure gauges. See drawings for locations.

.2 Wiring by Division 26.

2.5 **MONITORING (FLOW) SWITCHES**

.1 All shut-off valves shall be complete with ULC approved supervisory switches; each switch to be separately annunciated, and be complete with two (2) sets of contacts.

.2 Plug-type monitoring switches are not acceptable.

.3 Wiring by Division 26.

2.6 **DOUBLE CHECK VALVE BACKFLOW PREVENTER ASSEMBLY**

.1 Assembly shall be equal to Watts Regulator Limited Model 909RPDA. See drawings for location.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install to NFPA 13 and to manufacturer's written instructions.

.2 Install buried shut-off valves in valve box. Provide post indicator.

.3 Provide approved double check valve assembly at sprinkler system water source connection.

.4 Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.

.5 Locate outside alarm gong on building wall as indicated.

.6 Place pipe runs to minimize obstruction to other work.

.7 Place piping in concealed spaces above finished ceilings.

.8 Centre sprinklers in two (2) directions in ceiling tile and provide piping offsets as required one direction only in ceiling tile with location in other direction variable, dependent upon spacing and coordination with ceiling elements.

.9 Flush entire piping system of foreign matter.

.10 Hydrostatically test entire system.

.11 Require test be witnessed by authority having jurisdiction.

.12 The Site Services Contractor and/or Mechanical Contractor will install a water service into the building as shown on the drawings and specified. The Sprinkler Contractor shall complete a working sprinkler system from this interface connection. See schematic on drawings.

.13 Provide all necessary piping including fittings and unions to complete the systems shown. Cut pipes true and square, ream, file ends to smooth surface, all to pipe manufacturer's and accepted trade standards. Fittings shall be of equivalent bore as pipe, of equal strength and weight. Install piping to manufacturer's specifications and published directions.

.14 Install system drains to discharge to adjacent floor drains.

.15 Install zone test valves and piping to discharge to trench floor drain.

3.2 **TESTS**

.1 In addition to tests required by local authorities, test piping in presence of Commissioning Agent as hereinafter described.

.2 Notify the Commissioning Agent in writing at least forty-eight (48) hours prior to start of test. Failure to do so may require tests to be re-done.

.3 Pressure test sprinkler piping with 200 psig (1380 kPa) cold water for not less than four (4) hours without decrease in pressure.

.4 Perform tests on concealed piping before concealing in structure. Protect equipment and parts not capable of withstanding test pressure during tests.

.5 Make leaks tight while systems are still under test. If this is impossible, remove and re-fit defective parts. Caulking of threaded joints or welds will not be permitted.

.6 After leaks have been repaired, repeat tests as often as necessary ensure tightness of each system.

.7 The Contractor is to provide two (2) copies of testing data, reports and final acceptance from the representative of the local Fire Department and submit the results to the Consultant.

3.3 **IDENTIFICATION SIGNS**

.1 Provide each control valve, shut-off valve, drain valve and test valve with a sign. Size of sign shall be 6" x 6" (150 mm x 150 mm) for automatic control valves and alarm valves and 2" x 6" (50 mm x 150 mm) for other valves. Inscription shall be in accordance with Canadian Underwriters' Association standards. Sign shall be made of enamelled steel with Fire Department "RED" enamel background, white enamel letters and shall be fastened in a workmanlike manner to the pipe or structure in the immediate vicinity of the valve identified.

.2 Signs chained to valves are not acceptable.

3.4 **INSTRUCTIONS TO OPERATOR**

.1 Instruct Owner's Building Operator in care, maintenance and operation of Sprinkler System and associated equipment.

.2 Provide a typewritten description of care, maintenance and operation of the systems in a three-ring binder.

3.5 **FINAL INSPECTION**

.1 Arrange for the completed installation to be inspected by the Municipal Fire Department and present to the Architect, four (4) copies of Certificate or Letter of Approval.

3.6 **GUARANTEE**

.1 Furnish to the Owner through General Contractor and Architect, a written guarantee covering materials and workmanship and free service as per General Conditions.

.2 Guarantee shall entail the repair and replacement of materials without charge to the Owner except, where in the opinion of the Architect, such repair or replacement was caused by improper use or lack of maintenance during the guarantee period.

3.7 **INTERFACE WITH OTHER PRODUCTS**

.1 Ensure required devices are installed and connected as required to fire alarm system.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Pipe, pipe fittings, valves, and connections for piping systems sanitary sewer, domestic water, storm water, and natural gas.

1.2 RELATED SECTIONS

.1 Section 09 91 22 - Painting.

.2 Section 23 05 48 - Vibration Isolation.

.3 Section 23 05 53 - Mechanical Identification.

.4 Section 23 07 19 - Piping Insulation.

.5 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

.4 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.5 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

.6 ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.

.7 ASME B16.29 - Wrought Copper & Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

.8 ASME B16.50 - Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.

.9 ASME B31.2 - Fuel Gas Piping.

.10 ASME B31.9 - Building Services Piping.

.11 ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

.12 ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

.13 ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

.14 ASTM B32) - Standard Specification for Solder Metal.

.15 ASTM B75/B75M - Standard Specification for Seamless Copper Tube.

.16 ASTM B88M - Standard Specification for Seamless Copper Water Tube.

.17 ASTM B88 - Standard Specification for Seamless Copper Water Tube.

.18 ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).

.19 ASTM B837 - Standard Specification for Seamless Copper Tube for Natural Gas and Liquified Petroleum (LP) Gas Fuel Distribution Systems.

.20 ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.21 ASTM - D1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

.22 ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

.23 ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

.24 ASTM D2464 - Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

.25 ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.

.26 ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

.27 ASTM F442 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).

.28 AWWA C651 - Disinfecting Water Mains.

.29 CAN/CSA-B70 - Cast Iron Soil Pipe, Fittings, and Means of Joining.

.30 CAN/CSA-B1800 - Thermoplastic Nonpressure Piping Compendium.

.31 CAN/CSA-B137 - Thermoplastic Pressure Piping Compendium.

.32 CAN/CSA-B602 - Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe.

.33 CAN/ULC-S102.2 - Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies.

.34 ANSI Z21.22-2015/CSA 4.4 - Relief Valves for Hot Water Supply Systems.

.35 NSF 61 - Drinking Water System Components - Health Effects.

1.4 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of valves.

1.5 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Perform Work to local Municipality standards. Maintain one (1) copy of document on site.

.3 Valves: Manufacturer's name and pressure rating marked on valve body.

.4 Welding Materials and Procedures: Conform to ASME BPVC-Section IX applicable provincial labour regulations.

.5 All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

.6 All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.6 **REGULATORY REQUIREMENTS**

.1 Perform Work to applicable plumbing code.

.2 Conform to applicable code for installation of backflow prevention devices.

.3 Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.7 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept valves on site in shipping containers with labelling in place. Inspect for damage.

.3 Provide temporary protective coating on cast iron and steel valves.

.4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

.5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 **SITE CONDITIONS**

.1 Ambient Conditions: Do not install underground piping when bedding is wet or frozen.

Part 2 - Products

2.1 **SANITARY SEWER PIPING, BURIED, INSIDE BUILDING**

.1 ABS Pipe: CAN/CSA-B1800, Type DWV.

.1 Fittings: ASTM D2465, ABS threaded type, Schedule 80 ASTM D2468, ABS socket type, Schedule 40.

.2 Joints: ASTM D2235, solvent cement and primer for fittings; ASTM D3138, solvent cement and primer for transition joints.

.2 PVC Pipe: CAN/CSA-B182.1, SDR 35 pipe.

.1 Fittings: CAN/CSA-B182.2, ASTM D2729, socket type, SDR 35.

.2 Joints: ASTM D2564 solvent cement and primer.

.3 PVC Pipe: CAN/CSA-B182.2, SDR 35 pipe

.1 Fittings: CAN/CSA-B182.1, CAN/CSA-B182.2, ASTM D3034, ASTM F1336.

.2 Joints: Gasketed joints.

.4 PVC Pipe: CAN/CSA-B181.2, Schedule 40 pipe.

.1 Fittings: CAN/CSA-B181.2, Schedule 40.

.2 Joints: ASTM D2564 solvent cement and primer.

.5 Copper Tube: ASTM B306, DWV.

.1 Fittings: ASME B16.23, cast bronze ASME B16.29, wrought copper.
Joints: ASTM B32, soldered, AWS A5.8/A5.8M brazed.

2.2 **SANITARY SEWER PIPING, ABOVE GROUND**

.1 Cast Iron Pipe: CAN/CSA-B70.

.1 Fittings: Hubless Cast Iron Pipe Fittings: FSWW-P-401.

.2 Joints: ASTM C564, rubber or compression gaskets.

.2 Copper Tube: ASTM B306, DWV.

.1 Fittings: ASME B16.23 cast bronze ASME B16.29 wrought copper.

.2 Joints: Joints: ASTM B32, soldered AWS A5.8/A5.8M brazed.

2.3 **DOMESTIC WATER PIPING, ABOVE GROUND**

.1 Copper Tubing: ASTM B88M (ASTM B88)

.1 Fittings: ASME B16.18 cast copper alloy, ASME B16.22 wrought copper and bronze, ASME B16.26 cast copper alloy ASME B16.50 wrought copper.

.2 Joints: ASTM B32 soldered, AWS A5.8/A5.8M brazed.

2.4 **STORM WATER PIPING, BURIED, INSIDE BUILDING**

.1 ABS Pipe: CAN/CSA-B1800, Type DWV.

.1 Fittings: ASTM D2468, ABS socket type, Schedule 40, ASTM D2465, ABS threaded type, Schedule 80.

.2 Joints: ASTM D2235, solvent cement and primer for fittings; ASTM D3138, solvent cement and primer for transition joints.

.2 PVC Pipe: CAN/CSA-B182.1, SDR 35 pipe.

.1 Fittings: CAN/CSA-B182.2, ASTM D2729, socket type, SDR 35.

.2 Joints: ASTM D2564 solvent cement and primer.

.3 PVC Pipe: CAN/CSA-B182.2, SDR 35 pipe.

.1 Fittings: CAN/CSA-B182.1, CAN/CSA-B182.2, ASTM D3034, ASTM F1336.

.2 Joints: Gasketed joints.

.4 PVC Pipe: CAN/CSA-B181.2, Schedule 40 pipe.

.1 Fittings: CAN/CSA-B181.2, Schedule 40.

.2 Joints: ASTM D2564 solvent cement and primer.

2.5 **STORM WATER PIPING, ABOVE GROUND**

.1 Cast Iron Pipe: CAN/CSA-B70.

.1 Fittings: Hubless Cast Iron Pipe Fittings: FSWW-P-401.

.2 Joints: ASTM C564, rubber or compression gaskets.

.2 Copper Tube: ASTM B306, DWV.

.1 Fittings: ASME B16.23, cast bronze ASME B16.29, wrought copper.

.2 Joints: Joints: ASTM B32, soldered AWS A5.8/A5.8M brazed.

2.6 **NATURAL GAS PIPING, INSIDE BUILDING**

.1 Steel Pipe: ASTM A53/A53M, Schedule 40, Grade B black steel pipe, electric resistance welded.

.1 Fittings: ASME B16.3, malleable iron threaded fittings (for pipe diameters up to 50 mm (2 inches)) or ASME B16.9, wrought steel butt welding fittings.

.2 Joints: Steel flanges and fittings to ASME B16.5; unions to ASME B16.9.

2.7 **FLANGES, UNIONS, & COUPLINGS**

.1 Ferrous Pipe Size 75 mm (3 inches) and Under: Class 150 malleable iron threaded unions.

.2 Copper Tube and Pipe Size 75 mm (3 inches) and Under: Class 150 bronze unions with soldered joints.

.3 Ferrous Pipe Size Over 25 mm (1 inch): Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

.4 Copper Tube and Pipe Size Over 25 mm (1 inch): Class 150 slip-on bronze flanges; preformed neoprene gaskets.

.5 Grooved and Shouldered Pipe End Couplings:

.1 Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.

.2 Sealing gasket: C-shape composition sealing gasket.

.6 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.8 PIPE HANGERS & SUPPORTS

.1 Plumbing Piping - Drain, Waste, and Vent:

.1 Conform to ASME B31.9, ASTM F708.

.2 Hangers for Pipe Sizes 13 to 38 mm (1/2 to 1-1/2 inch): Malleable iron, Carbon steel, adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 50 mm (2 inches) and Over: Carbon steel, adjustable, clevis.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.5 Wall Support for Pipe Sizes to 75 mm (3 inches): Cast iron hook.

.6 Wall Support for Pipe Sizes 100 mm (4 inches) and Over: Welded steel bracket and wrought steel clamp.

.7 Vertical Support: Steel riser clamp.

.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.2 Plumbing Piping - Water:

.1 Conform to ASME B31.9, ASTM F708.

.2 Hangers for Pipe Sizes 13 to 38 mm (1/2 to 1-1/2 inch): Carbon steel Malleable iron, adjustable swivel, split ring.

.3 Hangers for Cold Pipe Sizes 50 mm (2 inches) and Over: Carbon steel, adjustable, clevis.

.4 Hangers for Hot Pipe Sizes 50 to 100 mm (2 to 4 inches): Carbon steel, adjustable, clevis.

.5 Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.

.6 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm (6 inches) and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.

.7 Wall Support for Pipe Sizes to 75 mm (3 inches): Cast iron hook.

.8 Wall Support for Pipe Sizes 100 mm (4 inches) and Over: Welded steel bracket and wrought steel clamp.

.9 Vertical Support: Steel riser clamp.

.10 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.11 Floor Support for Hot Pipe Sizes to 100 mm (4 inches): Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.

.12 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.9 **GATE VALVES**

.1 Gate Valves Up To and Including 75 mm (3 inches): Class 125 or Class 150, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder or threaded ends.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

.2 Gate Valves 50 mm (2 inches) and Larger: Class 125, iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends. Provide chain-wheel operators for valves 150 mm (6 inches) and larger mounted over 2400 mm (8 ft.) above floor.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

2.10 **GLOBE VALVES**

.1 Globe Valves Up To and Including 75 mm (3 inches): Class 125, bronze body, bronze trim, handwheel, bronze teflon disc, solder threaded ends.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

.2 Globe Valves 50 mm (2 inches) and Larger: Class 125, iron body, bronze trim, handwheel, outside screw and yoke, renewable bronze plug-type disc, renewable seat, flanged ends. Provide chain-wheel operators for valves 150 mm (6 inches) and larger mounted over 2400 mm (8 ft.) above floor.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

2.11 **BALL VALVES**

.1 Ball Valves 100 mm (4 inches) and Smaller: Class 150, 2760 kPa (400 psi) CWP, bronze, two-piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder or threaded ends with union.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

2.12 **PLUG VALVES**

.1 Plug Valves 65 mm (2-1/2 inches) and Larger: 1200 kPa (175 psi) CWP, cast iron body and plug, pressure lubricated, teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

2.13 **BUTTERFLY VALVES**

.1 Butterfly Valves 38 mm (1-1/2 inches) and Larger: 1380 kPa (200 psi) CWP, cast or ductile iron body, nickel-plated ductile iron, aluminum bronze, elastomer coated ductile iron disc, resilient replaceable EPDM, Buna N, EPT seat, wafer, lug, grooved ends, extended neck, 10 position lever handle or infinite position lever handle with memory stop. Provide gear operators for valves 150 mm (6 inches) and larger, and chain-wheel operators for valves mounted over 2.4 m (8 ft.) above floor.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

.2 2" to 24" (50 mm to 600 mm) grooved ends, ductile iron body, stainless steel stem with elastomer seat, pressure responsive in sizes through 12", disc mounted for 14 and larger. (Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.)

.1 Victaulic Vic300 MasterSeal and AGS Vic300.

2.14 **SWING CHECK VALVES**

.1 Swing Check Valves Up To and Including 75 mm (3 inches): Class 125, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends.

.1 Crane

.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

.2 Swing Check Valves 50 mm (2 inches) and Larger: Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

2.15 SPRING LOADED CHECK VALVES

.1 Spring Loaded Check Valves: Class 125, Class 150, iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

.2 2" to 24" (50 mm to 600 mm): Grooved end ductile iron body, with stainless steel spring, suitable for vertical installation.

.1 Stainless steel disc with elastomer seat / seal.
.2 Elastomer coated ductile iron disc with welded-in nickel seat.
.3 Victaulic Series 716 and AGS W715.

2.16 WATER PRESSURE REDUCING VALVES

.1 Water Pressure Reducing Valves Up to 50 mm (2 inches): bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded and single union or double union ends.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

.2 Water Pressure Reducing Valves Over 50 mm (2 inches): cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell

.4 Milwaukee
.5 Kitz
.6 Bray

2.17 **RELIEF VALVES**

.1 Pressure Relief Valves: ANSI Z21.22/CSA 4.4, certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

.2 Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 98.9 degrees C (210 degrees F), capacity, certified and labelled.

.1 Crane
.2 Newman-Hattersley
.3 Grinnell
.4 Milwaukee
.5 Kitz
.6 Bray

2.18 **STRAINERS**

.1 Strainers 50 mm (2 inch) and Under: Class 150 threaded brass body for 1200 kPa (175 psi) or 2070 kPa (300 psi) CWP, Y pattern with 0.8 mm (1/32 inch) stainless steel perforated screen.

.2 Strainers 38 mm (1-1/2 inch) to 100 mm (4 inch): Class 125, flanged iron body, Y pattern with 1.6 mm (1/16 inch) stainless steel perforated screen.

.3 Strainers 125 mm (5 inch) and Larger: Class 125, flanged iron body, basket pattern with 3.2 mm (1/8 inch) stainless steel perforated screen.

.4 Strainers: 2" to 18" (50 mm to 450 mm), grooved end “Y" pattern ductile iron body with coupled cover for strainer maintenance, stainless steel perforated metal basket, rated for working pressure to 300 psig CWP.

.1 Victaulic Style 732 and AGS W732.

2.19 **FIRE STOP SYSTEMS**

.1 General Purpose Fire Stopping Sealant: Water based, nonslumping, premixed sealant with intumescent properties, rated for 3 hours to ASTM E814 and UL 1479.

.2 General Purpose Vibration Resistant Fire Stopping Sealant: Silicone based, nonslumping, premixed sealant with intumescent properties, vibration and moisture resistant, rated for three (3) hours per ASTM E814 and UL 1479.

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verify existing conditions before starting work.

.2 Verify that excavations are to required grade, dry, and not over-excavated.

3.2 **PREPARATION**

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

.2 Remove scale and dirt, on inside and outside, before assembly.

.3 Prepare piping connections to equipment with flanges or unions.

3.3 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Provide non-conducting dielectric connections wherever jointing dissimilar metals.

.3 Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

.4 Install piping to maintain headroom, conserve space, and not interfere with use of space.

.5 Group piping whenever practical at common elevations.

.6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

.7 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.

.8 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with General Division.

.9 Install vent piping penetrating roofed areas to maintain integrity of roof assembly.

.10 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

.11 Provide support for utility meters to requirements of utility companies.

.12 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.

.13 Excavate to Section 31 00 00 - Earthwork for work of this Section.

.14 Backfill to Section 31 00 00 - Earthwork for work of this Section.

.15 Install bell and spigot pipe with bell end upstream.

.16 Install valves with stems upright or horizontal, not inverted.

.17 Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.

.18 Install water piping to ASME B31.9.

.19 Sleeve pipes passing through partitions, walls and floors.

.20 Inserts:

.1 Provide inserts for placement in concrete formwork.

.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm (4 inches).

.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of, above, or recessed into and grouted flush with slab.

.21 Pipe Hangers and Supports:

.1 Install to ASME B31.9, ASTM F708.

.2 Support horizontal piping as scheduled.

.3 Install hangers to provide minimum 15 mm (1/2 inch) space between finished covering and adjacent work.

.4 Place hangers within 300 mm (12 inches) of each horizontal elbow.

.5 Use hangers with 40 mm (1-1/2 inch) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

.6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Provide copper plated hangers and supports for copper piping sheet lead packing between hanger or support and piping.

.9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

.10 Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 23 05 48.

.11 Support cast iron drainage piping at every joint.

.22 DO NOT use PVC type piping when pipe is complete with pipe insulation and electrical heat tracing.

3.4 **APPLICATION**

.1 Use grooved mechanical couplings and fasteners only in accessible locations.

.2 Install unions downstream of valves and at equipment or apparatus connections.

.3 Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

.4 Install valves for shut-off and to isolate equipment, part of systems, or vertical risers.

.5 Install valves for throttling, bypass, or manual flow control services.

.6 Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.

.7 Provide spring loaded check valves on discharge of water pumps.

.8 Provide plug valves in natural gas systems for shut-off service.

.9 Provide flow controls in water recirculating systems where indicated.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

.1 Disinfect water distribution system.

.2 Prior to starting work, verify system is complete, flushed and clean.

.3 Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

.4 Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

.5 Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15% of outlets.

.6 Maintain disinfectant in system for twenty-four (24) hours.

.7 If final disinfectant residual tests less than 25 mg/L, repeat treatment.

.8 Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

.9 Take samples no sooner than twenty-four (24) hours after flushing, from 10%, 5%, 2% of outlets and from water entry, and analyze to AWWA C651.

.10 Coordinate with Commissioning Agent.

.11 Submit final report.

3.6 SERVICE CONNECTIONS

.1 Provide new sanitary and storm sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

.2 Provide new water service complete with approved double check backflow preventer and water meter with by-pass valve.

.1 Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

.2 Provide 1.2 mm (18 gauge) galvanized sheet metal sleeve around service main to 150 mm (6 inch) above floor and 1800 mm (6 ft.) minimum below grade. Size for minimum of 50 mm (2 inches) of loose batt insulation stuffing.

.3 Provide new gas service complete with gas meter and regulators. Pay all fees to the local Gas Utility for the new gas service.

3.7 SCHEDULES

.1 Pipe Hanger Schedule:

.1 Metal Piping:

.1 Pipe size: 15 to 32 mm (1/2 to 1-1/4 inches):

.1 Maximum hanger spacing: 2 m (6.5 ft.).

.2 Hanger rod diameter: 9 mm (3/8 inches).

.2 Pipe size: 40 to 50 mm (1-1/2 to 2 inches):

.1 Maximum hanger spacing: 3 m (10 ft.).

.2 Hanger rod diameter: 10 mm (3/8 inch).

.3 Pipe size: 65 to 75 mm (2-1/2 to 3 inches):

.1 Maximum hanger spacing: 3 m (10 ft.)

.2 Hanger rod diameter: 13 mm (1/2 inch).

.4 Pipe size: 100 to 150 mm (4 to 6 inches):

.1 Maximum hanger spacing: 3 m (10 ft.).

.2 Hanger rod diameter: 15 mm (5/8 inch).

.5 Pipe size: 200 to 300 mm (8 to 12 inches):

.1 Maximum hanger spacing: 4.25 m (14 ft.).

.2 Hanger rod diameter: 22 mm (7/8 inch).

.6 Pipe size: 350 mm and Over (14 inches and Over):

.1 Maximum hanger spacing: 6 m (20 ft.).

.2 Hanger rod diameter: 25 mm (1 inch).

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Roof and floor drains.

.2 Cleanouts.

.3 Backflow preventers.

.4 Water hammer arrestors.

.5 Truck Water Fill Station.

.6 Water Meter.

.7 Roof Vent Caps.

.8 Trap Seal Primer.

.9 Trench Drains.

.10 Domestic Water Recovery Heat Exchanger.

.11 Domestic Water Expansion Absorber.

1.2 RELATED SECTIONS

.1 Section 22 10 00 - Plumbing Piping.

.2 Section 22 42 02 - Plumbing Fixtures.

.3 Section 22 47 00 - Plumbing Equipment.

1.3 REFERENCES

.1 Conform the latest edition, including Amendments of the following Codes and Standards.

.2 Local bylaws and standards.

.3 Ontario Electrical Safety Code (latest edition).

.4 Ontario Building Code (OBC)

.5 ACNBC Canadian Plumbing Code.

.6 ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.

.7 AWWA C510 - Double Check Valve Backflow Prevention Assembly.

.8 AWWA C511 - Reduced-Pressure Principle Backflow Prevention Assembly.

.9 ASSE (Plumbing) 1011 - Performance Requirements for Hose Connection Vacuum Breakers.

.10 ASSE (Plumbing) 1012 - Performance Requirements for Backflow Preventer with Intermediate Atmospheric Vent.

.11 ASSE (Plumbing) 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.

.12 ASSE (Plumbing) 1019 - Performance Requirements for Wall Hydrants with Backflow Protection and Freeze Resistance.

.13 PDI-G 101 - Testing and Rating Procedure for Hydro Mechanical Grease Interceptors with Appendix of Installation and Maintenance.

.14 PDI-WH 201 - Water Hammer Arrestors.

1.4 **SUBMITTALS FOR REVIEW**

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

.3 Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for the following equipment:

.1 Trench Drains

.2 Grease Interceptor

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Certificates: Certify that grease oil interceptors meet or exceed specified requirements.

.3 Installation Data: Manufacturer's special installation requirements including assembly and support requirements.

1.6 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation Data: Indicate frequency of treatment required for interceptors.

.3 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

.4 Record Documentation: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.

.5 Submit inspection certificates obtained from local inspection authorities.

.6 Submit certificates indicating that all required testing has been completed..

1.7 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.8 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept specialties on site in original factory packaging. Inspect for damage.

Part 2 - Products

2.1 **FLOOR DRAINS - DESIGNATED FD**

.1 In finished areas, floor drains shall be cast iron body with 5" (127 mm) Type "B" nickel bronze strainer, and trap primer connection. Zurn ZN-211-B-P. In waterproof membrane areas, use Zurn ZN-415 body.

.2 Shower Drains shall be Zurn ZN415-B5-P Cast iron floor drain for membrane with a 213 mm (8 3/8") in diam., reversible clamp collar with lateral openings on top, body with a 102 mm (4") in diam. threaded throat to receive adjustable 127 mm (5") in diam. adjustable round strainer combined with 13 mm (1/2") round polished nickel bronze regular traffic grate. Trap primer protection.

.3 Hub drains shall be installed next to equipment where only one (1) pipe has to relieve to drain and shall be cast iron body with 4" (100 mm) polished nickel bronze round strainer and trap primer connection. Zurn ZN-211BE-P-YS. In waterproof membrane areas, use Zurn ZN-415-BE-P-YS bucket and trap primer connection. DESIGNATED HD

.4 Funnel floor drains shall be installed next to equipment where more than one (1) pipe has to relieve to drain and shall be cast iron body with 4" x 8" (100 mm x 200 mm) polished nickel bronze round strainer and trap primer connection. Zurn ZN-211-BF-P. In waterproof membrane areas, use ZN-401-BF-P. DESIGNATED FFD

.5 In electrical, mechanical and sprinkler rooms floor drains shall be ZXN211-A5-AR Cast iron with anticorrosive finish floor drain with a 165 mm (6 1/2") in diam. body with a 102 mm (4") in diam. threaded throat to receive adjustable 127 mm (5") in diam. adjustable round strainer combined with 13 mm (1/2") round polished nickel bronze heavy traffic grate.

.6 Acceptable Products:

.1 Zurn

.2 Watts

.3 Jay R. Smith

.4 Mifab

.7 Before construction begins, the Prime Mechanical Contractor shall obtain from the General Division the "Room Finish Schedule" for the Project. The Prime Mechanical Contractor and the floor drain manufacturer and/or vendor shall coordinate the type and installation of the various floor drains listed in the Specifications for each Room. If there is a discrepancy, advise the Consultant before submitting the approval drawings for review. Failure to do so will result in the Prime Mechanical Contractor bearing the total cost for replacing the floor drains and repairing the floor to match the existing conditions.

2.2 **TRENCH DRAINS - DESIGNATED TD**

.1 Zurn Z886-CBF-CBFFEC Pre-slopped high density polyethylene trench drain water proof and highly resistant to a variety of chemical products, interlocking section of 2032 mm (80") in length by 159 mm (6 1/4") in width, extra-heavy duty black acid resistant coated steel 2032 mm (80") frame for trench drain, integral rebar clips, 137 mm (5 3/8") grates as per application. Concrete slab surrounding the trench drain to respect manufacturer recommendations. DGE (Z883 / Z886) Heavy duty ductile iron, black enamel finish class DIN E grate, 137 x 508 mm (5 3/8 x 20 in) in length (4 grates required per trench), class DIN C. Z887-IA6 Transition flange between trench drain and catch basin. JC (Z886) Joint connection for nose to nose installation.

2.3 **TRENCH DRAINS - DESIGNATED TD-1**

.1 Zurn Z884 pre-slopped high density polyethylene trench drain water-proof and highly resistant to a variety of chemical products, interlocking section of 1016 mm (40") in length by 121 mm (4 3/4") in width, integral rebar clips, 105 mm (4 1/8") grates as per application. fs (z884) light duty slotted trench drain stainless steel grate, 105 x 508 mm (4 1/8 x 40 in) in length (1 grate required per trench), class DIN A. E1 (Z884) trench drain closed end cap. u3 (Z884) trench drain 76 mm (3 in) bottom connection.

2.4 **DOMESTIC WATER RECOVERY HEAT EXCHANGER - DESIGNATED DHWR-1**

.1 Power-Pipe Model C6-96 by RenewABILITY Energy. 152mm diameter Copper DWV in accordance with ASTM B306. 25 mm diameter Type L ASTM B88 Copper tube. CSA B55.2 certified. Pressure tested to 160 PSI.

2.5 **ROOF DRAINS - DESIGNATED RD-1**

.1 Provide to the General Division for installation, the roof drains as listed below.

.2 Zurn ZCF 121. 12" (305 mm) diameter "Control-Flo" roof drain for dead-level roof construction, Dura-Coated cast iron body. Combination membrane flashing clamp/gravel guard, aluminum "Control-Flo" weir, and Poly-Dome. "Con-trol-Flo" weir shall be linear functioning with flow rate of 5 GPM (23 LPM) per inch of water buildup above drain. All data shall be verified proportional to flow rates.

.3 Acceptable Products:

.1 Zurn

.2 Watts

.3 J. R. Smith

2.6 **CLEANOUTS - DESIGNATED CO**

.1 Provide at the base of each vertical stack and rainwater leader, Zurn Z-1445.

.2 Provide on exposed wall areas, accessible pipe chases, and outside grade, Zurn Z-1440.

.3 Provide on plaster walls, Zurn Z-1446-Z-VP.

.4 Provide on finished floor areas, Zurn ZN-1602-T, square nickel bronze access cover and frame to suit floor finish.

.5 Provide in ceramic or quarry tile floor areas, Zurn ZN-1602-T square nickel bronze access cover and frame.

.6 Provide on unfinished floor areas, Zurn Z-1602-T with cast iron scoriated top.

.7 Provide on vinyl tile floor areas, Zurn ZN-1614 with nickel bronze top recessed for tile.

.8 Provide for terrazzo floor areas, Zurn ZN-1607-ST with nickel bronze top recessed for terrazzo.

.9 Cleanouts installed in water-proofed areas shall be supplied with flashing flange and clamp collar.

.10 Provide in carpeted floor areas, Zurn ZN-1602 CM round nickel bronze top and carpet marker.

.11 Acceptable Products:

.1 Zurn

.2 Watts

.3 Jay R. Smith

.4 Enpoco

.5 Mifab

.12 Before construction begins, the Prime Mechanical Contractor shall obtain from the General Division the "Room Finish Schedule" for the Project. The Prime Mechanical Contractor and the cleanout manufacturer and/or vendor shall coordinate the type and installation of the various cleanouts listed in the Specifications for each Room. If there is a discrepancy, advise the Consultant before submitting the approval drawings for review. Failure to do so will result in the Prime Mechanical Contractor bearing the total cost for replacing the cleanouts and repairing the floor to match the existing conditions.

2.7 **TRAP SEAL PRIMERS - DESIGNATED TSP**

.1 For multiple installation, trap seal primer shall be gravity feed, prime time electronic priming manifold equal to Precision Plumbing Products, Model PT. Manifold openings to be determine on site.

.2 Unit shall be factory assembled and pre-piped complete with vacuum breaker, bronze body valve, water hammer arrestor, solenoid valve and calibrated type 'L' copper manifold. Manifold complete with brass compression fittings with orificed openings.

.3 Unit shall be complete with manual over-ride switch, breaker and 24 hour geared timer.

.4 All components shall be installed in a 16 gauge enclosure complete with access door for surface mounting.

.5 Install unit to Manufactures instructions.

.6 For individual installation, supply and install trap seal primer equal to Precision Plumbing Products, Model P-2-500.

.7 Acceptable Products:

.1 Precision Plumbing Products

.2 Mifab

.3 Zurn

2.8 **TRUCK FILLING STATION - DESIGNATED TF**

.1 National fire equipment model 264. Polished chrome finish.

2.9 **THERMAL EXPANSION ABSORBER - POTABLE WATER HEATING**

.1 Supply and install a diaphragm expansion tank specifically designed for potable water heating systems with 40 psi (275 kPa) pre-charge pressure and 125 psi (865 kPa) working pressure, to absorb the expansion of the hot water tank recovery heating, of the size shown on Drawings.

.2 Connect a cold water supply line to the hot water tank and mount absorber on floor with a thermal loop pipe separation to the hot water tank.

.3 Acceptable Products:

.1 Amtrol

.2 Hamlet and Garneau

.3 Letrol

2.10 **DIELECTRIC UNIONS**

.1 Provide wherever pipes of dissimilar metals are joined.

.2 Provide insulating unions for pipe sizes 2" (50 mm) and under and flanges for pipe sizes 2-1/2" (65 mm) and over.

.3 Cast brass adapters may be used where approved by the Consultant.

.4 Provide an isolating separation wherever piping may touch dissimilar metal studs, joists, concrete, etc.

2.11 ROOF VENT CAPS

.1 Pre-insulated aluminum stack-jack flashing with vandal proof cap.

.2 All new roof vent caps to be Provided with insulated vent stacks supplied by Division 15 and installed by Division 07. This Division to connect new vents to stacks.

.3 Acceptable Products:

.1 Thaler Metal Industries Inc., Model SJ-26 EPDM (or PVC) with SJ-33 stainless steel vandal proof cap.

.2 Lexcor Flash-Tile, Vandal proof Model VSC-V.

.3 Famco

2.12 WATER FEED PRESSURE REGULATOR SYSTEMS

.1 Supply as part of each system water feed regulator, a 3/4" (20 mm) diameter manual feed independent of pressure regulator for quick filling.

.2 Install backflow preventer to meet plumbing regulations with upstream shut-off valve on each assembly.

2.13 SHOCK ABSORBERS

.1 At each group of fixtures supply and install shock absorber, Zurn Model Z-1700. Contractor shall guarantee no water hammer for one (1) year. for shock absorbers concealed in walls Provide access door for servicing.

.2 Acceptable Products:

.1 Zurn

.2 Watts

.3 J.R. Smith

.4 PPP Inc.

.5 Mifab

2.14 WATER METER

.1 Supply and install a 100 mm (4") diameter water meter where indicated on the Mechanical Drawings. Coordinate with local Region requirements for water meter installation.

.2 Meter to meet the requirements of ANSI/AWWA Standard C701 and C702 Class II.

.3 The measuring assembly to be complete with floating ball impeller with coated titanium shaft, hybrid axial bearings, integral flow straightener and an

.4 all-electronic programmable register with protective bonnet. The main case is made from ductile iron with an approved NSF epoxy coating, easily removable measuring chamber, chamber seal, testing port and integral strainer.

.5 Meter registration is achieved by utilizing a fully magnetic pick-up system. This is accomplished by the magnetic actions of the embedded rotor magnets and the ultra sensitive register pick-up probe. The only moving component in water is the floating ball impeller.

.6 The Measuring Element is a thermoplastic hydro-dynamically balanced impeller that floats between the bearings. The floating ball technology (FBT) allows the measuring element to operate virtually without friction or wear.

.7 The integral strainer using a stainless steel screen along with FBT create a design that gives far improved accuracy even in those once though to be questionable settings. A removable strainer cover permits easy access to the screen for routine maintenance. Drain ports, located at the back, lower corners of the strainer body allow for easy discharge of debris without the need to remove the cover.

.8 Acceptable Products: As per local Region Standards

2.15 **BACKFLOW PREVENTER - DESIGNATED BFP, BFP-1 etc.**

Application	Type	Description
Watermain bldg. entry	Dual check valve assembly	Two independent check valves. Checks are replaceable for repair and testing
Boilers	Specialty BFP with intermediate atmospheric vent	Two independent check valves with intermediate vacuum breaker and relief vent
Dishwasher, hose reel	Atmospheric vacuum breakers	Single float and disc with atmospheric port
Commercial laundry	Pressure vacuum breakers	Spring-loaded float and disc with independent check. Supplied with shutoff valves and ball type test cocks
Hose bibbs, Janitor sinks, truck fill station	Hose connection vacuum breakers	Single check with atmospheric vacuum breaker vent

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

.3 Encase exterior cleanouts in concrete flush with grade.

.4 Install floor cleanouts at elevation to accommodate finished floor.

.5 Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.

.6 Pipe relief from backflow preventer to nearest drain.

.7 Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to sinks lavatories washing machine outlets.

.8 Install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 20 mm (3/4 inch) minimum, and minimum 450 mm (18 inches) long.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Water closets.

.2 Lavatories.

.3 Sinks.

.4 Service sinks.

.5 Showers.

.6 Hose Station.

.7 Bottle Fill Station.

.8 Master Mixing Valve.

.9 Eye/Face wash fountains.

1.2 RELATED SECTIONS

.1 Section 22 10 00 - Plumbing Piping.

.2 Section 22 42 01 - Plumbing Specialties.

.3 Section 22 47 00 - Plumbing Equipment.

.4 Section 23 05 29 - Supports & Anchors.

.5 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

.4 ASME A112.18.1/CSA-B125.1 - Plumbing Supply Fittings.

.5 ASME A112.19.1/CSA B45.2 - Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures.

.6 ASME A112.19.2/CSA-B45.1 - Ceramic Plumbing Fixtures.

.7 ASME A112.19.5/CSA-B45.15 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks.

.8 ISEA Z358.1 - Emergency Eye Wash and Shower Equipment.

.9 CSA (Canadian Standards Association).

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, trim, utility sizes, finishes.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 **CLOSEOUT SUBMITTALS**

.1 Maintenance Data in accordance with Section 01 78 23 - Operation and Maintenance Manuals: Include fixture trim exploded view and replacement parts lists.

.2 Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Submit maintenance and extra material requirements.

.2 Spare Parts: Supply two (2) sets of faucet washers flush valve service kits lavatory supply fittings shower heads toilet seats.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.9 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept fixtures on site in factory packaging. Inspect for damage.

.3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

Part 2 - Products

2.1 **PLUMBING FIXTURES**

.1 All plumbing fixtures are based on Zurn, Elkay and Can-Aqua. Alternate Products are American Standard, Kohler, Crane. Water closets shall be certified to CAN/CSA-B45.0. All plumbing fixtures to be supported, level and square.

.2 Stainless steel sinks "KS" designations are Elkay and Alternate Products are: Franke, Kindred Ind. Ltd., Architectural Metal Industries, Aristaline.

.3 Master mixing valve "MMV" shall be: Base Bid: Leonard, Alternate Products: Powers, Lawler, Symmons.

.4 Shower "SH" shall be Alternate Products: Acorn, Symmons, Powers.

.5 Water Closet seats shall be Alternate Products: Centoco, Olsonite and Bemis.

.6 Janitor Sink "JS" shall be Alternate Products: Fiat, Stern Williams and Zurn.

.7 Emergency Eyewash EWW shall be Alternate Products: Haws, Bradley.

.8 All fittings shall be brass, chrome plated finish. Plastic fittings are not acceptable. Cambridge Brass fittings are specified. Alternate products are American Standard, Moen and Chicago Faucet, except where specifically noted as special manufacture. Fittings and trim serving Lavatory, stainless steel sinks and showers shall be certified to CAN/CSA-B125.

.9 This section shall caulk all gaps between porcelain plumbing fixture and finished wall/floor and counter top with white silicone caulking. Engage the respective trade on site to do this work.

.10 All vitreous china fixtures are white unless specified otherwise.

.11 Flushometer valve shall be: Alternate Products: Crane, Cambridge Brass, Zurn.

.12 Fixture carriers shall be: Alternate Products: Zurn, Watts and J.R. Smith.

.13 Provide each fixture with separate waste and trap, vent and water, as shown or required in accordance with the following schedule:

Fixture	Trap (mm)	Vent (mm)	Cold (mm)	Hot (mm)
Lavatory	1-1/4" (32)	1-1/4" (32)	1/2" (15)	1/2" (15)
Water Closet (FV)	3" (80)	1-1/2" (40)	1" (25)	--
Janitor's Sink	3" (80)	1-1/2" (40)	1/2" (15)	1/2" (15)
Kitchen Sink	1-1/2" (40)	1-1/4" (32)	1/2" (15)	1/2" (15)
Floor & Hub Drain; Funnel Drain & Trench Drain	3" (80 min.)	1-1/2" (40)	3/8" (10)	--
Shower Stall	2" (50)	1-1/2" (40)	1/2" (40)	1/2" (15)
Shower Mixing Valve	--	--	3/4" (20)	3/4" (20)
Bathtub	1-1/2" (40)	1-1/4" (32)	1-1/2" (40)	1-1/2" (40)
Hose Bibb	--	--	3/4" (20)	3/4" (20)
Non-Freeze Hose Bibb	--	--	3/4" (20)	--
Laundry Tub	1-1/2" (40)	1-1/4" (32)	1/2" (15)	1/2" (15)

.14 **Note:** Exposed drain pipe serving sink, lavatory and laundry tub, is to be finished chrome plate complete with deep cup escutcheon.

.15 Water Closet - Designated WCH-1 (Barrier Free Floor Mounted Toilet)

.1 Z5665-BWL1-AM Vitreous china elongated bowl with SmartSilver™ surface (antimicrobial finish), 425 mm (16 3/4 in) in height, siphon jet action, 54 mm (2 1/8 in) completely glazed trapway, bolt caps, 38 mm (1 1/2 in) top spud connection, 6 L (1.6 US gal) or 4.8 L (1.28 US gal) per flush, depending on the flush valve selected. ZER6000AV-1-IS-HET Exposed electronic gear driven flush valve for water closets, TPE chloramine resistant dual seal diaphragm with triple filter by-pass, powered by hardwired 6 VDC power converter, infrared convergence type proximity sensor, motorized actuator with override button, metal casing, control stop with vandal resistant stop cap, cast wall flange, 38 mm (1-1/2 in) vacuum breaker tube with water supply 406 mm (16 in) above closet bowl, polished chrome finish, 4.8 L (1.28 US gal) per flush. Must be installed with electrical power converter 120 VAC/6 VDC (P6000-HW6). Verify the installation height of backrest and grab bar determined by architect. The flush tube may need to be cut. P6000-HW6 Hardwired power converter 120VAC/7.6 VDC, 2 amp, capable of supplying 8 faucets or 8 flush valves or 8 faucets/ flush valves combined. When used with W1 connected products, capable of supplying 6 faucets or 6 flush valves or 6 faucets/ flush valves combined. Z5956SS-AM Solid plastic elongated seat for super-intensive use with anti-microbial protection, open front, coverless, molded bumper guard, stainless steel check hinges and fasteners. (White). 3777-T1-8 Stainless steel tubular backrest of 32 mm (1 1/4 in), satin finish, recessed fasteners, phenolic composite backplate 102 mm (4 in) in height x 254 mm (10 in) in length, antique white. "A" dimension of 203 mm (8 in).

.16 Water Closet - Designated WC-1 (Free Floor Mounted Toilet)

.1 Z5665-BWL1-AM Vitreous china elongated bowl with SmartSilver™ surface (antimicrobial finish), 425 mm (16-3/4 in) in height, siphon jet action, 54 mm (2 1/8 in) completely glazed trapway, bolt caps, 38 mm (1-1/2 in) top spud connection, 6 L (1.6 US gal) or 4.8 L (1.28 US gal) per flush, depending on the flush valve selected. ZER6000AV-1-IS-HET Exposed electronic gear driven flush valve for water closets, TPE chloramine resistant dual seal diaphragm with triple filter by-pass, powered by hardwired 6 VDC power converter, infrared convergence type proximity sensor, motorized actuator with override button, metal casing, control stop with vandal resistant stop cap, cast wall flange, 38 mm (1 1/2 in) vacuum breaker tube with water supply 406 mm (16 in) above closet bowl, polished chrome finish, 4.8 L (1.28 US gal) per flush. Must be installed with electrical power converter 120 VAC/6 VDC (P6000-HW6). Verify the installation height of backrest and grab bar determined by architect. The flush tube may need to be cut. P6000-HW6 Hardwired power converter 120VAC/7.6 VDC, 2 amp., capable of supplying 8 faucets or 8 flush valves or 8 faucets/ flush valves combined. When used with W1 connected products, capable of supplying 6 faucets or 6 flush valves or 6 faucets/ flush valves combined. Z5956SS-AM Solid plastic elongated seat for super-intensive use with anti-microbial protection, open front, coverless, molded bumper guard, stainless steel check hinges and fasteners. (White).

.17 Lavatory - Designated LH-1 (Barrier Free Wall Hung Lavatory)

.1 SOFIA A32772200A Undermount vitreous china sink DIMENSIONS: 24 x 16-2/16 x 8 5/16 inches ZG6953-ADM - Camaya Series™ Sensor Faucet Designed for modern commercial restrooms, Camaya Series™ touchless sensor faucet delivers a superior user experience in both form and function. Plus, our Camaya Series™ Battery Sensor Faucets now come standard with Hydro-X Power to deliver seamless, sustainable performance at the sink—up to ten or more years without a single battery replacement! The technology generates enough power from only a few activations a day, even with the lowest flow rate, to optimize both energy and water. 0.5 GPM flow rate with above deck mixer. P6000-HW6 Hardwired power converter 120VAC/7.6 VDC, 2 amp., capable of supplying 8 faucets or 8 flush valves or 8 faucets/ flush valves combined. When used with W1 connected products, capable of supplying 6 faucets or 6 flush valves or 6 faucets/ flush valves combined. ZH8824XL-Q-PC/Z8952-58 (2) Extra heavy duty quarter turn stops, low lead, DN 1/2 in compression x 3/8 in compression, wheel handle, flanges chrome plated finish. 12-ZW1070XL-C Thermostatic mixing valve supplying 1 or multiple lavatories/sinks designed for point of use; 37.8 L/min (10 US gpm) flow at a 45 psi pressure differential; temperature setting at 35 to 46 deg. C (95 to 115 deg. F) with a + 1.78 deg. C (3 deg. F) precision at a 0.95 L/min (0.25 US gpm) minimum flow; inlets check valves with incorporated filters, (1/2" sweat) inlets and outlet. Standards: CSA B125-70, ASSE 1070, NSF/ANSI 61-9* 37DWC 32 mm "Daisy" type strainer offset drain assembly, cast brass body, 32 mm (1-1/4 in), polished chrome finish. Z8700-8BD-PC 32 mm (1 1/4") Cast brass adjustable P-trap, 32 mm (1-1/4 in) with deep wall flange and cleanout, chrome plate finish. Z8946-3-NT

.2 Antimicrobial protectors, resists thermal transfers for P-trap, offset drain assembly, stop and supply.

.18 Lavatory - Designated L-1 (Wall Hung Lavatory)

.1 SOFIA A32772200A Undermount vitreous china sink DIMENSIONS: 24 x 16-2/16 x 8-5/16 inches ZG6953-ADM - Camaya Series™ Sensor Faucet Designed for modern commercial restrooms, Camaya Series™ touchless sensor faucet delivers a superior user experience in both form and function. Plus, our Camaya Series™ Battery Sensor Faucets now come standard with Hydro-X Power to deliver seamless, sustainable performance at the sink - up to ten or more years without a single battery replacement! The technology generates enough power from only a few activations a day, even with the lowest flow rate, to optimize both energy and water. 0.5 GPM flow rate with above deck mixer. P6000-HW6 Hardwired power converter 120VAC/7.6 VDC, 2 amp., capable of supplying 8 faucets or 8 flush valves or 8 faucets/ flush valves combined. When used with W1 connected products, capable of supplying 6 faucets or 6 flush valves or 6 faucets/ flush valves combined. ZH8824XL-Q-PC/Z8952-58 (2) Extra heavy duty quarter turn stops, low lead, DN 1/2 in compression x 3/8 in compression, wheel handle, flanges chrome plated finish. 12-ZW1070XL-C Thermostatic mixing valve supplying 1 or multiple lavatories/sinks designed for point of use; 37.8 L/min (10 US gpm) flow at a 45 psi pressure differential; temperature setting at 35 to 46 deg. C (95 to 115 deg. F) with a + 1.78 deg. C (3 deg. F) precision at a 0.95 L/min (0.25 US gpm) minimum flow; inlets check valves with incorporated filters, [1/2" sweat] inlets and outlet. Standards: CSA B125-70, ASSE 1070, NSF/ANSI 61-9* 37DWC 32 mm "Daisy" type strainer offset drain assembly, cast brass body, 32 mm (1-1/4 in), polished chrome finish. Z8700-8BD-PC 32 mm (1 1/4") Cast brass adjustable P-trap, 32 mm (1 1/4 in) with deep wall flange and cleanout, chrome plate finish.

.19 Sink - Designated KS-1 (Double Basin Undermount Stainless Steel Sink)

.1 Elkay EFRU311810T/LK35 781 x 470 x 254 mm (30-3/4 x 18-1/2 x 10") Stainless steel double bowl sink for universal / undermount installation, 781 x 470 x 254 mm (30-3/4 x 18-1/2 x 10 in), type 304, 16 gauge, satin finish, sound deadening pads, rim seal pre-installed, installation kit, 89 mm (3-1/2 in) basket strainer assembly LKAV1061LS Single-lever faucet, cast brass body, ceramic disc cartridges, lustrous steel finish, with lever handle, 216 mm (8-1/2 in) swivel 360° gooseneck spout with aerator limiting flow to 6.8 lpm (1.8 gpm). Maximum countertop thickness 64 mm (2 1/2 in). Cover plate model LK134. Standards: ASME A112. 18. 1/CSA B125.1 ZH8824XL-LRLKQ-8860-12-PC (2) 10 x 300 mm (3/8 x 12") Extra heavy duty quarter turn stops, low lead, DN 1/2 in compression, loose key, vertical flexible stainless braided hoses of 10 x 300 mm (3/8 x 12 in), flange, chrome plated finish. Z8702-9BD 38 mm (1 1/2") Cast brass adjustable P-Trap, 38 mm (1 1/2 in) with cleanout, deep seal flange, polished chrome finish.

.20 Sink - Designated KS-2 (Sink Basin Undermount Stainless Steel Sink)

.1 Elkay ECTRU24179RT-LK35 648 x 470 x 228 mm (25-1/2 x 18-1/2 x 9") Undermount stainless steel single bowl sink inside rounded squared corners, 648 x 470 x 228 mm (25-1/2 x 18-1/2 x 9 in), type 304, 18 gauge, satin finish, sound deadening pads, rim seal pre-installed, installation kit, 89 mm (3 1/2 in) right rear basket strainer assembly. LKAV1061LS Single-lever faucet, cast brass body, ceramic disc cartridges, lustrous steel finish, with lever handle, 216 mm (8 1/2 in) swivel 360° gooseneck spout with aerator limiting flow to 6.8 lpm (1.8 gpm). Maximum countertop thickness 64 mm (2-1/2 in). Optional cover plate model LK134 sold separately Standards: ASME A112. 18. 1/CSA B125.1 ZH8824XL-LRLKQ-8860-12-PC (2) 10 x 300 mm (3/8 x 12") Extra heavy duty quarter turn stops, low lead, DN 1/2 in compression, loose key, vertical flexible stainless braided hoses of 10 x 300 mm (3/8 x 12 in), flange, chrome plated finish. Z8702-9BD 38 mm (1-1/2") Cast brass adjustable P-Trap, 38 mm (1 1/2 in) with cleanout, deep seal flange, polished chrome finish.

.21 Sink - Designated S-1 (Laundry Utility Sink)

.1 Can-Aqua CA-EUPS-3624 999 x 698 mm (39 1/3 x 27 1/2") Single stainless steel utility sink on legs, 999 x 698 mm (39 1/3 x 27 1/2 in), 304 type, 18 gauge, satin finish, 0.625 radius corner, 229 mm (9 in) backsplash, rounded rim, stainless steel legs with adjustable feet, 89 mm (3 1/2 in) basket strainer assembly situated in center of bowl. Backsplash predrilled as per required. Suffix for hole drilling: ST: No holes 10: Single holes 24: 2 holes 4 in center 34: 3 holes 4 in center 28: 2 holes 8 in center 38: 3 holes 8 in center PS: Special hole drilling. Z843H4-XL Polished chrome-plated cast brass 203 mm (8 in) sink faucet with quarter turn ceramic disc cartridges, low lead, 102 mm (4 in) vandal-resistant color-coded metal wrist blade handles, integral service stops, 305 mm (12 in) tubular brass swing spout, 8.3 L/min. (2.2 USGPM) vandal-resistant pressure compensating laminar flow. Z8702-9BD 38 mm (1 1/2") Cast brass adjustable P-Trap, 38 mm (1 1/2 in) with cleanout, deep seal flange, polished chrome finish.

.22 Shower - Designated SH (Non-Barrier Free Shower)

.1 7600-H-15. Thermostatic (T type) mixing valve for concealed piping, copper encapsulated thermostat assembly with brass shuttle, compensates for temperature and minor pressure fluctuation, rotation from cold to hot, high temperature limit stop factory preset at 43 deg. C (110 deg. F), brass body, internal brass, copper and stainless steel components, metal trim and handle, color-coded indicator, combined service stops/check stops, DN 13 mm (1/2") sweat inlet and outlet, DN 13 mm (1/2") threaded bottom outlet, 15 L/min (4 USGPM) flow. Institutional adjustable water saver shower head, chromed thermoplastic ABS body, ball joint, 5.7L/min (1.50 USGPM), chromed brass mounting plate with optional chromed brass anchor plate.

.23 Shower - Designated SH-1 (Non-Barrier Free Shower)

.1 7600 Thermostatic (T type) mixing valve for concealed piping, copper encapsulated thermostat assembly with brass shuttle, compensates for temperature and minor pressure fluctuation, rotation from cold to hot, high temperature limit stop factory preset at 43 deg. C (110 deg. F), brass body, internal brass, copper and stainless steel components, metal trim and handle, color-coded indicator, combined service stops/check stops, DN 13 mm (1/2") sweat inlet and outlet, DN 13 mm (1/2") threaded bottom outlet, 15 L/min (4 USGPM) flow. Standards: ASME A112. 18. 1/CSA B125.1 H-15 Adjustable water saver institutional shower head, chromed thermo-plastic ABS body, ball joint, 5.7 L/min (1.5 USGPM), chromed brass mounting plate with optional chromed brass anchor plate. 62001-1.5-72 Hand shower kit including: 38 mm (1 1/2") in diam. x 610 mm (24") grab bar, sliding and pivoting hand shower hanger manageable by hand or with closed fist requires no more than 2.27 kg (5 lbs) pressure to operate, institutional hand shower with instant shut-off button, 5.7 l/min (1.5 USGPM) flow with integral check stops, DN 1/2" wall mount supply elbow with flange. Braided stainless steel double spiral metallic hose flexible and extended out from 72". D-2L Recessed diverter, chrome plated lever handle with flange, DN 1/2 in sweat.

.24 Bottle Fill Station - DF (Bottle Fill Station)

.1 EZWS8K. In wall sensor activated upper bottle filling station, non-filtered, 1.1 gpm laminar flow fill, 20 sec automatic shutoff timer and Green counter for plastic bottles saved from landfills, key plastic components with ion anti-microbial protection. 32 mm (1-1/4 in) trap (not supplied). non-filtered, integral flow control, 120 V, 60 HZ, R134A refrigerant, R134A refrigerant, Compressor: Hermetically-sealed, reciprocating type, single phase. Sealed-in lifetime lubrication, Condenser: Fan cooled, copper tube with aluminum fins. Fan motor is permanently lubricated. Cooling Unit: Combination tube-tank type. Continuous copper tubing with is fully insulated with EPS foam that meets UL requirements for self-extinguishing material, plug-in power supply cord, 30.3 L/ph (8.0 USGPH) capacity at a 10 deg. C (50 deg. F) temperature, 27 deg. C (80 deg. F) incoming water supply and 32 deg. C (90 deg. F) ambient air Temperature. Sensor activated bottle filling station, 1.1 gpm laminar flow fill, 20 second automatic shutoff timer and Green counter for plastic bottles saved from landfills, key plastic components with ion anti-microbial protection. ASME A112.19.3/CSA B45.4. NSF/ANSI 61-372, UL 399. Zurn foresee straight screwdriver stop(s), 10 mm (3/8 in) flexible hose with wall flange, polished chrome finish. Zurn Z8700-8BD-PC 32 mm (1 1/4") Cast brass adjustable P-trap, 32 mm (1 1/4 in) with deep wall flange and cleanout, chrome plate finish. Zurn Z1225/EZWSMDK Concealed wall hung carrier, extra-heavy duty top and bottom adjustable plates, steel uprights with welded feet, mounting fastener. MFWS100 Mounting frame. EWF3000 In-line filter for lead removal, cartridge form, polypropylene casing, 5 1/4 dia. x 12.7 in, 3/8 in inlet and 1/4 in outlet, built-in filter (lifetime 1 year or 3000 gallons, 1.5 gpm. Filters particulate lead at 1 micron and chlorine. NSF 42, 53, 372.

.25 Janitor Sink - Designated JS (Floor Mounted Stainless Steel Janitors Sink)

.1 Can-Aqua CA-EVC2424-P-J Stainless steel mop basin, type 304, 16 gauge, 610 x 610 x 254/406 mm (24 x 24 x 10/16 in), #4 finish internal surfaces, rim and backsplash panel, corner installation, front skirt, 152 mm (6 in) high integrated backsplash, center drain, pre-slopped, interior square corners, 38 mm (1 1/2 in) flattened rim. DN 76 mm (3 in) stainless steel dome strainer/lint basket with locking nut, neoprene gasket for push-on connections. Z843M1-RC-CS Wallmount polished chrome-plated cast brass 203 mm (8 in) sink faucet, low lead, short swivel inlets, 184 to 222 mm (7 1/4 to 8 3/4 in) adjustable centers, integral service stops, ceramic disc cartridges, rough chrome finish, 64 mm (2 1/2 in) vandal resistant color-coded lever handles, rigid spout with atmospheric vacuum breaker, wall brace, pail hook and hose threaded outlet, outlet at 232 mm (9 1/8 in) from finished wall. Integral service/check stops. Standards: ASME A112. 18. 1/CSA B125.1 Z1996-HH 16 X 762 mm (5/8 x 30 po) Reinforced hose for intensive use 16 x 762 mm (5/8 x 30 in) in length with brass coupling with hose bracket with rubber grip. Z1996-MH 610 x 76 mm (24 x 3") Stainless steel mop hanger, with 3 wall hooks.

.26 Emergency Eye Wash Designated EEW

.1 Encon 01035401 Wall mounted emergency eyewash or eye/face wash, 274 mm (10.8") yellow ABS receptor, laminar flow eyewash, yellow ABS eyewash head with water pressure activated yellow plastic pop-off dust cover, integral 30 L/min (8 USGPM) flow control, chrome-plated brass stay-open ball valve equipped with stainless steel ball and stem, push flag activated sign, 16 stainless mesh screen (1190 microns) in-line filter, DN 1/2" water supply, cast-aluminum chromate protected wall bracket, satin finish chrome plated DN 1 1/4" waste with universal pictogram. Operating pressure is 30-70 psi. TA-300-LF-RF Bronze DURA-Trol® solid bi-metal thermostat compensating for temperature and pressure variations. 1.9-38 l/min (0.5 - 10 USGPM) flow for a pressure loss up to 45 psi. May be adjusted to the desired temperature. Locking temperature regulator to prevent accidental movement set for 29 deg. C (85 deg. F), Mixing valve will close down on failure of cold water supply. Mixing valve with special internal cold water by-pass capable of a minimum 15 l/min (4 USGPM) at 30 psi (2.1 bar) upon failure of hot water. High temperature limit stop factory preset at 32 deg. C (90 deg. F). Integral wall support. DN 1/2 in inlets with angle check stops, DN 1/2 in outlet. Rough bronze finish. Dial thermometer. Required hot water supply at 60 deg. C (140 deg. F) min. Complies to ANSI Z358.1 2004. Option : top inlets. Standards: CSA B125.3, ASSE 1071 Z8700-8BD-PC 32 mm (1-1/4") Cast brass adjustable P-trap, 32 mm (1-1/4 in) with deep wall flange and cleanout, chrome plate finish.

.27 Thermostatic Mixing Station - Designated TMX

.1 PNV-200-LF Digital thermostatic mixing valve, inlet DN 2 in, outlet DN 2 in, minimum flow of 0.95 to 625 l/min (0.25 to 173 US gpm) at 30 psi pressure drop, digital thermostat, +/- 2 deg. F water temperature control, 2 deg. F minimum inlet to outlet water temperature differential, automatic shutoff of hot water upon cold water inlet supply failure, automatic shutoff of cold water upon hot water inlet supply failure, maintain last control position in the event of power failure or be equipped with UPS standby power for approximately 2 hour run time, programmable set point range of 65-180 deg. F (18-82 deg. C), self-balancing - No need to manually adjust or balance recirculation, self-cleaning - Daily shuttle sweep keeps shuttle free of debris Connectivity capabilities 120V plug in power supply with 6' cord 2 line, 16 character LED display BMS connectivity available as option with Protocast (IOT) Shall be compliant with ASSE standard 1017 and CSA B125/cUPC and so certified and identified, Shall be cULus listed and identified PNV-200-LF.

.28 Hose Rell - Designated HS (Commercial/Industrial Hose Reel)

.1 Industrial and Commercial Hose Reels RH1000 Charland Thermojet HIGH PRESSURE SPRING REWIND REELSView Print Version with TECH DATA. To handle single 1/4" or 3/8" I.D. Hose. Industrial Hose reels Compact frame and narrow base. Non sparking ratchet assembly Declutching arbor to prevent damage from reverse winding. Standard inlet 900 swivel joint 1/4" female NPT threads. 3/8" female NPT threads. Standard outlet is 1/4" female NPT threads. 3/8" female NPT threads are optional and must be specified. Other threads can be furnished and must be specified Standard pressure of 10,000 psi (689 bar), product temperatures from -40 deg. F to +250 deg. F (-40 deg. C to + 121 deg. C). Optional 1/4" 3000 psi (207 bar), or 3/8" 3000 psi (207 bar) or 8000 psi (552 bar) are available upon request. 4-way roller assembly. Constant Tension is available - consult factory.

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verify existing conditions before starting work.

.2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.

.3 Verify that electric power is available and of the correct characteristics.

.4 Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2 **PREPARATION**

.1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Install each fixture with trap, easily removable for servicing and cleaning.

.3 Provide chrome plated rigid or flexible supplies to fixtures with screwdriver stops, reducers, and escutcheons.

.4 Install components level and plumb.

.5 Install and secure fixtures in place with wall supports wall carriers and bolt, washer, nut fasteners.

.6 Seal fixtures to wall and floor surfaces with approved sealant .

.7 Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.4 **INTERFACE WITH OTHER PRODUCTS**

.1 Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation. Co-ordinate the installation of stainless steel sinks and lavatories with the millwork. If there is a discrepancy, advise the Consultant before submitting approval drawings. Failure to do this will result in the Contractor bearing the total cost for replacing sinks that do not fit properly in counter tops.

3.5 **ADJUSTING**

.1 Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 **CLEANING**

.1 Section 01 74 11 - Cleaning: Cleaning installed work.

.2 Clean plumbing fixtures and equipment.

3.7 **PROTECTION OF FINISHED WORK**

.1 Protect installed work.

.2 Do not permit use of fixtures.

3.8 **SCHEDULES**

.1 Fixture Heights: Install fixtures to heights above finished floor as indicated.

.1 Set lavatory (Designated 'L') from floor to lip at 31" (775 mm).

.2 Set Watercloset (Designated 'WC') from floor to lip at 15" (375 mm).

.3 Set Watercloset (Designated 'WCH') from floor to lip at 17" (425 mm).

.4 Set domestic water faucet and/or laundry mate at 48" (1200 mm) above floor.

.5 Mount shower (DESIGNATED 'SH') metering valve at 54" (1350 mm) above floor and shower head at 6'-6" (1980 mm) above floor.

.6 Mount shower (DESIGNATED 'SH-1') metering valve at 38" (965 mm) above floor and handheld shower mounting bracket at 48" (1200 mm) and head at 6'-0" (18000 mm) above floor.

.7 Set isolation valves serving laundry machines at 6'-0" (1800 mm) above floor.

.8 Mount emergency eye wash (DESIGNATED EEW) at 48" (1200 mm) above floor.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Expansion tanks.

.2 Pumps.

1.2 RELATED REQUIREMENTS

.1 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASME Boiler and Pressure Vessels Code (BPVC), Section VIII - Rules for Construction of Pressure Vessels.

.4 CSA-B51 - Boiler, Pressure Vessel, and Pressure Piping Code.

.5 NEMA 250 - Enclosures for Electrical Equipment (1000 Volt Maximum).

.6 NFPA 30 - Flammable and Combustible Liquids Code.

.7 NFPA 31 - Standard for the Installation of Oil-Burning Equipment.

.8 NFPA 54/ANSI Z223.1 - National Fuel Gas Code.

.9 NFPA 58 - Liquefied Petroleum Gas Code.

.10 UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters.

.11 UL 174 - Standard for Household Electric Storage Tank Water Heaters.

.12 CSA (Canadian Standards Association).

.13 UL (Underwriters Laboratories Inc.).

1.4 ACTION SUBMITTALS

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.

.2 Indicate pump type, capacity, power requirements.

.3 Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

.4 Provide electrical characteristics and connection requirements.

.3 Shop Drawings:

.1 Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

1.5 INFORMATIONAL SUBMITTALS

.1 Section 01 33 00: Submission procedures.

.2 Installation Data: Manufacturer's special installation requirements.

1.6 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of components.

.3 Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

.4 Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials: Provide two (2) sets of pump seals for each pump. Provide two (2) sets of cartridges for each side-stream filter.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

.3 Provide pumps with manufacturer's name, model number, and rating/capacity identified.

.4 Ensure products and installation of specified products are to recommendations and requirements of the following organizations:

.1 American Gas Association (AGA).

.2 National Sanitation Foundation (NSF).

.3 American Society of Mechanical Engineers (ASME).

.4 National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).

.5 National Electrical Manufacturers' Association (NEMA).

.6 Underwriters Laboratories (UL).

.5 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of midpoint of published maximum efficiency curve.

1.9 **REGULATORY REQUIREMENTS**

.1 Conform to NFPA 54/ANSI Z223.1, NFPA 58, UL 1453 requirements for water heaters.

.2 Conform to ASME BPVC-Section VIII for tanks.

.3 Products Requiring Electrical Connection: Listed and classified by CSA UL testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.10 **DELIVERY, STORAGE, & HANDLING**

.1 Transport, handle, store, and protect products.

.2 Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.11 **WARRANTY**

.1 Provide a five (5) year warranty to include coverage for failure to meet specified requirements, for domestic water heaters, water storage tanks, packaged water heating systems, in-line circulator, submersible sump pumps, sump pumps, sewage ejectors.

Part 2 - Products

2.1 **DIAPHRAGM-TYPE COMPRESSION TANKS - EXP-1**

.1 Manufacturers:

.1 Amtrol

.2 Watts

.2 **Construction:** Welded steel, tested and stamped to ASME BPVC-Section VIII; supplied with National Board Form U-1, rated for working pressure of 860 kPa (125 psig), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

.3 **Accessories:** Pressure gauge and air-charging fitting, tank drain; pre-charge to 80 kPa (12 psig).

.4 For Model Number and tank size, refer to Mechanical Drawings.

2.2 **DOMESTIC RECIRCULATION PUMP - DESIGNATED P-1**

.1 Furnish and install, as shown on the plans, Armstrong Compass R circulating pump model with high efficiency ECM motor and 5 modes of control, in stainless steel/ductile iron body and Noryl impeller. The pump shall have a capacity of 5 USGPM (L/s) against a total head of 15 ft. Armstrong Compass R Series are 115V/208-240V/single phase/50/60 Hz and are cETLus listed.

.2 Stainless steel body Compass is NSF 372 & NSF-61 certified which complies with Section 116875 of the California Health and Safety Code and Vermont Act 193. (Lead content of all wetted surface is 0.25% or less.)

.3 Design is based on Armstrong

.4 Acceptable Products:

.1 Armstrong

.2 Taco

.3 Wilo

2.3 **HYDRONIC CIRCULATOR PUMP - DESIGNATED HP-1**

.1 Pump casing shall be cast iron, suitable for 175 psi (1206 kPa) working pressure at 140 deg. F (60 deg. C). Ductile iron pump casings are suitable for pressures to 250 psi (1724 kPa). The casing shall be hydrostatically tested to 150% maximum working pressure.

.2 The casing shall be radially split to allow removal of the rotating element without disturbing the pipe connections.

.3 The casing suction and discharge connections shall be the same size and shall be provided with drilled and tapped seal vent and pressure gauge connections.

.4 Pump impeller shall be bronze, fully enclosed type. Impeller shall be dynamically balanced.

.5 A bronze shaft sleeve, extending the full length of the mechanical seal area, shall be provided.

.6 Mechanical Seal shall be single spring inside type with carbon against Ceramic faces. EPDM elastomer with stainless steel spring and hardware shall be provided. Seal vent line shall be factory installed and shall be piped from the seal area to the pump suction connection.

.7 Motor power requirements shown on the pump schedule are the minimum acceptable and have been sized for continuous operation without exceeding the full load nameplate rating over the entire pump curve, exclusive of service factor.

.8 Design is based on Armstrong.

.9 Acceptable Products:

.1 Armstrong

.2 Taco

.3 Wilo

Part 3 - Execution

3.1 **INSTALLATION**

.1 **Pumps - General:**

.1 Provide air cock and drain connection on horizontal pump casings.

.2 Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.

.3 Decrease from line size with long radius reducing elbows or reducers.

.4 Support piping adjacent to pump such that no weight is carried on pump casings.

.5 Provide supports under elbows on pump suction and discharge line sizes 100 mm (4 inches) and over.

.6 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.

.7 Align and verify alignment of base mounted pumps prior to start-up.

.2 **In-Line Circulator - P-1**

.1 Install as indicated by flow arrows. Support at flanges or near unions on outlets of unit. Install with bearing lubrication points accessible. Check rotation.

.2 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

.3 Ensure that the pump is free to float with expansion and contraction of the piping.

.3 **Impeller Adjustment:** Include in the Contract the amount necessary to have the Pump Supplier's Service Representative visit site and machine down or replace impellers for circulating and vertical in-line pumps as requested by the Balancing Contractor.

.4 **Replacement Seals:**

.1 Supply and install in each of the in-line circulating pumps and vertical pumps, a new set of mechanical seals. These shall be installed after the cleaning and flushing operation but prior to the addition of the final chemical treatment.

.2 If the seals removed are in good condition, they will be turned over to the Owner.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Flexible pipe connectors.

.2 Expansion joints and compensators.

.3 Pipe loops, offsets, and swing joints.

1.2 RELATED SECTIONS

.1 Section 21 11 00 - Fire Protection Piping.

.2 Section 22 10 00 - Plumbing Piping.

.3 Section 23 21 00 - Hydronic Piping.

1.3 PERFORMANCE REQUIREMENTS

.1 Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.

.2 Expansion Calculations:

.1 Installation Temperature: 10 degrees C (50 degrees F).

.2 Hot Water Heating: 99 degrees C (210 degrees F).

.3 Domestic Hot Water: 60 degrees C (140 degrees F).

.4 Safety Factory: 30%.

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, fundamental frequency of assembly, braid structure, and total number of wires in braid.

.2 Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

.3 Samples: Submit two (2) samples of low pressure compensators: 19 mm (3/4 inch), 25 mm (1 inch), 30 mm (1-1/4 inch) in size.

1.5 CLOSEOUT SUBMITTALS

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

.3 Maintenance Data: Include adjustment instructions.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Stock Materials: Provide two (2), 340 gm (12 oz.) containers of packing lubricant and cartridge style grease gun.

1.7 **QUALITY ASSURANCE**

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

.2 Design expansion compensating system under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

1.8 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

.3 Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.9 **WARRANTY**

.1 Section 01 78 10 - Sample Guarantee/Warranty Form.

.2 Warranty: Include coverage for leak free performance of packed expansion joints.

Part 2 - Products

2.1 **FLEXIBLE PIPE CONNECTORS**

.1 **Steel Piping:**

.1 Manufacturers:

.1 Flexonics

.2 Kinetics

.3 Flexcraft

.2 Inner Hose: Stainless Steel.

.3 Exterior Sleeve: Braided, stainless steel.

.4 Pressure Rating: 1380 kPa (200 psig) WOG and 121 degrees C (250 degrees F).

.5 Joint: As specified for pipe joints.

.6 Maximum offset: 20 mm (3/4 inch) on each side of installed centre line.

.2 **Copper Piping:**

.1 Manufacturers:

.1 Flexonics

.2 Kinetics

.3 Flexcraft

.2 Inner Hose: Bronze.

.3 Exterior Sleeve: Braided bronze.

.4 Pressure Rating: 1380 kPa (200 psig) WOG and 121 degrees C (250 degrees F).

.5 Joint: Flanged As specified for pipe joints.

.6 Size: Use pipe sized units.

.7 Maximum offset: 20 mm (3/4 inch) on each side of installed centre line.

2.2 **ACCESSORIES**

.1 **Pipe Alignment Guides:** Two-piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 25 mm (1 inch) thick insulation, minimum 75 mm (3 inch) travel.

.2 **Swivel Joints:** Fabricated steel.

.3 **Mechanical Couplings:**

.1 Couplings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12.

.2 Grooved joints shall be installed in accordance with the manufacturer's latest published instructions.

.3 The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer.

.4 Installing Contractor to obtain on-site and off-site installation training from the coupling manufacturer and inform Consultant in writing that the training is complete.

.5 The manufacturer's factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

.6 Installing Contractor to complete manufacturer "Inspection Form" and forward to the Consultant for review.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Construct spool pieces to exact size of flexible connection for future insertion.

.3 Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

.4 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

.5 Rigidly anchor pipe to building structure where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

.6 Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required indicated.

.7 Provide Victaulic piping with minimum one joint per 25 mm (1 inch) pipe diameter instead of flexible connector supported by vibration isolation. Victaulic piping need not be anchored.

.8 Piping 2-1/2" (65 mm) and larger 150 lb (1035 kPa) flanged, self-equalizing, corrugated packless, stainless steel bellows, tie rods, or Victaulic Flexible Couplings as shown on drawings.

.9 Provide expansion loops as indicated on drawings.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Pressure gauges and pressure gauge taps.

.2 Thermometers and thermometer wells.

.3 Test plugs and kits.

1.2 RELATED SECTIONS

.1 Section 25 50 02 - Digital Control Equipment.

.2 Section 25 90 00 - Sequence of Operation.

.3 Section 23 21 00 - Hydronic Piping: Installation of thermometer wells.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASME B40.100 - Pressure Gauges and Gauge Attachments.

.4 ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers.

.5 ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide list which indicates use, operating range, total range and location for manufactured components.

1.5 CLOSEOUT SUBMITTALS

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of components and instrumentation.

1.6 SITE CONDITIONS

.1 Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.7 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Stock Materials:

.1 Provide two (2) bottles of red gauge oil for static pressure gauges.

.2 Provide two (2) each, dial thermometers, pressure gauges with pulsation damper.

Part 2 - Products

2.1 **PRESSURE GAUGES**

.1 Manufacturers:

.1 Trerice
.2 Winters
.3 Baker
.4 Weiss

.2 **Gauge:** ASME B40.100, drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

.1 Case: Cast aluminum with phosphor bronze bourdon tube.
.2 Size: 115 mm (4-1/2 inch) diameter.
.3 Mid-Scale Accuracy: 1%/2%/1/2%.
.4 Scale: Both kPa and psi.

2.2 **STEM TYPE THERMOMETERS**

.1 Manufacturers:

.1 Trerice
.2 Winters
.3 Baker
.4 Weiss

.2 **Thermometer:** ASTM E1, red appearing mercury, solar therm, lens front tube, cast aluminum case with enamel finish.

.1 Size: 175 mm (7 inch) scale.
.2 Window: Clear glass.
.3 Stem: 20 mm (3/4 inch) brass.
.4 Accuracy: ASTM E77, 2%.
.5 Calibration: Both degrees C and degrees F.

2.3 **DIAL THERMOMETERS**

.1 Manufacturers:

.1 Trerice
.2 Winters
.3 Baker
.4 Weiss

.2 **Thermometer**: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.

.1 Size: 75 mm (3 inch) diameter dial.
.2 Lens: Clear Lexan.
.3 Accuracy: 1%.
.4 Calibration: Both degrees F and degrees C

2.4 **TEST PLUGS**

.1 **Test Plug:** 6 mm (1/4 inch), brass fitting and cap for receiving 3 mm (1/8 inch) outside diameter pressure or temperature probe with neoprene core for temperatures up to 93 degrees C (200 degrees F).

.2 **Test Kit:** Carrying case, internally padded and fitted containing one (1) pressure gauge.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Provide one (1) pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

.3 Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 60 mm (2-1/2 inch) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

.4 Install thermometers in air duct systems on flanges.

.5 Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.

.6 Locate duct mounted thermometers minimum 3 m (10 ft.) downstream of mixing dampers, coils, or other devices causing air turbulence.

.7 Coil and conceal excess capillary on remote element instruments.

.8 Provide instruments with scale ranges selected according to service with largest appropriate scale.

.9 Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

.10 Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

.11 Locate test plugs adjacent thermometers and thermometer sockets, adjacent to pressure gauges and pressure gauge taps, adjacent to control device sockets where indicated.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Pipe and equipment hangers and supports.

.2 Equipment bases and supports.

.3 Sleeves and seals.

.4 Flashing and sealing equipment and pipe stacks.

1.2 RELATED SECTIONS

.1 Section 03 30 00 - Cast-in-place Concrete: Equipment bases.

.2 Section 07 84 00 - Firestopping: Joint seals for piping and duct penetration of fire rated assemblies.

.3 Section 09 91 22 - Painting.

.4 Section 21 11 00 - Fire Protection Piping.

.5 Section 23 07 19 - Piping Insulation.

.6 Section 23 07 16 - Equipment Insulation.

.7 Section 22 10 00 - Plumbing Piping.

.8 Section 23 21 00 - Hydronic Piping.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASME B31.2 - Fuel Gas Piping.

.4 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.

.5 ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

.6 MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

.7 MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

.8 NFPA 13 - Standard for the Installation of Sprinkler Systems

.9 NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.

.10 UL 203 - Pipe Hanger Equipment for Fire-Protection Service.

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide manufacturers catalogue data including load capacity.

.3 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

.3 Installation Data: Indicate special installation procedures and assembly of components.

1.6 **REGULATORY REQUIREMENTS**

.1 Conform to applicable code for support of plumbing and hydronic piping.

.2 Supports for Sprinkler Piping: To NFPA 13.

Part 2 - Products

2.1 **PIPE HANGERS & SUPPORTS**

.1 Acceptable Manufacturers:

.1 Anvil

.2 Myatt

.3 Economec

.2 **Fire Protection Piping:**

.1 Conform to NFPA 13 NFPA 14.

.2 Hangers for Pipe Sizes 13 to 38 mm (1/2 to 1-1/2 inch): Malleable iron Carbon steel, adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 50 mm (2 inches) and Over: Carbon steel, adjustable, clevis.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.5 Wall Support for Pipe Sizes to 75 mm (3 inches): Cast iron hook.

.6 Wall Support for Pipe Sizes 100 mm (4 inches) and Over: Welded steel bracket and wrought steel clamp.

.7 Vertical Support: Steel riser clamp Angle ring.

.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.3 **Plumbing Piping - DWV:**

.1 Conform to ASME B31.9 ASTM F708 MSS SP-58 MSS SP-58.

.2 Hangers for Pipe Sizes 13 to 38 mm (1/2 to 1-1/2 inch): Malleable iron Carbon steel, adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 50 mm (2 inches) and Over: Carbon steel, adjustable, clevis.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.5 Wall Support for Pipe Sizes to 75 mm (3 inches): Cast iron hook.

.6 Wall Support for Pipe Sizes 100 mm (4 inches) and Over: Welded steel bracket and wrought steel clamp.

.7 Vertical Support: Steel riser clamp.

.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.4 **Plumbing Piping - Water:**

.1 Conform to ASME B31.9 ASTM F708 MSS SP-58 MSS SP-58.

.2 Hangers for Pipe Sizes 13 to 38 mm (1/2 to 1-1/2 inch): Malleable iron Carbon steel, adjustable swivel, split ring.

.3 Hangers for Cold Pipe Sizes 50 mm (2 inches) and Over: Carbon steel, adjustable, clevis.

.4 Hangers for Hot Pipe Sizes 50 to 100 mm (2 to 4 inches): Carbon steel, adjustable, clevis.

.5 Hangers for Hot Pipe Sizes 150 mm (6 inches) and Over: Adjustable steel yoke, cast iron roll, double hanger.

.6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.7 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm (6 inches) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

.8 Wall Support for Pipe Sizes to 76 mm (3 inches): Cast iron hook.

.9 Wall Support for Pipe Sizes 100 mm (4 inches) and Over: Welded steel bracket and wrought steel clamp.

.10 Wall Support for Hot Pipe Sizes 150 mm (6 inches) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

.11 Vertical Support: Steel riser clamp.

.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.13 Floor Support for Hot Pipe Sizes to 100 mm (4 inches): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.14 Floor Support for Hot Pipe Sizes 150 mm (6 inches) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.5 **Hydronic Piping:**

.1 Conform to ASME B31.9 ASTM F708 MSS SP-58 MSS SP-58.

.2 Hangers for Pipe Sizes 13 to 38 mm (1/2 to 1-1/2 inch): Malleable iron Carbon steel, adjustable swivel, split ring.

.3 Hangers for Cold Pipe Sizes 50 mm (2 inches) and Over: Carbon steel, adjustable, clevis.

.4 Hangers for Hot Pipe Sizes 50 to 100 mm (2 to 4 inches): Carbon steel, adjustable, clevis.

.5 Hangers for Hot Pipe Sizes 150 mm (6 inches) and Over: Adjustable steel yoke, cast iron roll, double hanger.

.6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.7 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm (6 inches) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

.8 Wall Support for Pipe Sizes to 76 mm (3 inches): Cast iron hook.

.9 Wall Support for Pipe Sizes 100 mm (4 inches) and Over: Welded steel bracket and wrought steel clamp.

.10 Wall Support for Hot Pipe Sizes 150 mm (6 inches) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

.11 Vertical Support: Steel riser clamp.

.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.13 Floor Support for Hot Pipe Sizes to 100 mm (4 inches): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.14 Floor Support for Hot Pipe Sizes 150 mm (6 inches) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.6 **Refrigerant Piping:**

.1 Refrigerant piping shall be hung from cushion clamps, secured to unistrut, hung from threaded hanging rods. Minimum length of hanging rods to be 12" (300 mm). Install neoprene cover around pipe to prevent vibration and wear.

.2 Install filter, dryer, sight glass and thermal expansion valve on each system.

.3 Hot gas lines to be complete with oil traps.

.4 Piping outdoors to be mounted on roof sleepers. See Typical Piping Roof Support Detail on Mechanical Drawings. Provide neoprene cover to eliminate vibration and wear.

.5 Insulate liquid and suction lines with 1/2" (15 mm) Armaflex II pipe insulation sealed at joints with Armstrong 520 adhesive.

.6 Refrigerant pipe systems to be tested with nitrogen to 550 psig (3800 kPa) for twenty-four (24) hours and leaks repaired and piping retested before insulation is applied.

.7 Roof pipe sleeve shall be supplied by this Division and installed by the General Contractor.

.8 Roof pipe sleeve shall be supplied by and installed by the Owner approved Roofing Consultant/Contractor.

.9 After Refrigerant pipe installation is complete and tested, supply and charge each system with the correct quantity of oil and refrigerant.

2.2 ACCESSORIES

.1 Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.3 INSERTS

.1 Acceptable Manufacturers:

.1 Midwest Tucson

.2 Copper Industries

.3 Flocor

.2 **Inserts:** Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

.1 Metal Flashing: 0.50 mm (26 ga) galvanized steel.

.2 Metal Counterflashing: 0.80 mm (22 ga) galvanized steel.

.3 Flexible Flashing: 1.2 mm (47 mil) thick sheet butyl; compatible with roofing.

.4 Caps: Steel, 0.8 mm (22 ga) minimum; 1.5 mm (16 ga) at fire resistant elements.

2.5 **SLEEVES**

.1 Acceptable Manufacturers:

.1 Watts

.2 Metraflex

.3 GPT

.2 Sleeves for Pipes Through Non-fire Rated Floors: 1.2 mm thick (18 gauge) galvanized steel.

.3 Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 1.2 mm thick (18 gauge) galvanized steel.

.4 Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed, refer to Section 07 84 00.

.5 Sleeves for Round Ductwork: Galvanized steel.

.6 Sleeves for Rectangular Ductwork: Galvanized steel or wood.

.7 Firestopping Insulation: Glass fibre type, non-combustible; refer to Section 07 84 00.

.8 Sealant: Acrylic, refer to Section 07 92 0.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install components to manufacturer's written instructions.

3.2 **INSERTS**

.1 Provide inserts for placement in concrete formwork.

.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm (4 inches).

.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 **PIPE HANGERS & SUPPORTS**

.1 Support horizontal piping as scheduled.

.2 Install hangers to provide minimum 13 mm (1/2 inch) space between finished covering and adjacent work.

.3 Place hangers within 300 mm (12 inches) of each horizontal elbow.

.4 Use hangers with 38 mm (1-1/2 inch) minimum vertical adjustment.

.5 Support horizontal cast iron pipe adjacent to each hub, with 1.5 m (5 ft.) maximum spacing between hangers.

.6 Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Support riser piping independently of connected horizontal piping.

.9 Provide copper plated hangers and supports for copper piping and sheet lead packing between hanger or support and piping.

.10 Design hangers for pipe movement without disengagement of supported pipe.

.11 Prime coat exposed steel hangers and supports as specified in Section 09 91 22. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 **EQUIPMENT BASES & SUPPORTS**

.1 Provide housekeeping pads of concrete, minimum 100 mm (4 inches) thick and extending 150 mm (6 inches) beyond supported equipment. Refer to Section 03 30 00.

.2 Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

.3 Construct supports of steel members steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.4 Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 **FLASHING**

.1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 75 mm (3 inches) minimum above finished roof surface with lead worked 25 mm (1 inch) minimum into hub, 200 mm (8 inches) minimum clear on sides with 600 x 600 mm (24 x 24 inches) sheet size. for pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

.3 Flash floor drains in floors with topping over finished areas with lead, 250 mm (10 inches) clear on sides with minimum 910 x 910 mm (36 x 36 inch) sheet size. Fasten flashing to drain clamp device.

.4 Seal floor, shower, mop sink drains watertight to adjacent materials.

.5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's written instructions for sound control.

.6 Provide curbs for mechanical roof installations 350 mm (14 inches) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

.7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 **SLEEVES**

.1 Set sleeves in position in formwork. Provide reinforcing around sleeves.

.2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

.3 Extend sleeves through floors 25 mm (1 inch) above finished floor level. Caulk sleeves.

.4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

.5 Install chrome plated steel escutcheons at finished surfaces.

3.7 **SCHEDULES**

PIPE SIZE	**MAX. HANGER SPACING**	**DIAMETER**
12 - 32 mm (1/2 - 1-1/4 inch)	2 m (6.5 ft.)	9 mm (3/8 inch)
38 - 50 mm (1-1/2 - 2 inch)	3 m (10 ft.)	9 mm (3/8 inch)
62 - 75 mm (2-1/2 - 3 inch)	3 m (10 ft.)	13 mm (1/2 inch)
100 - 150 mm (4 - 6 inch)	3 m (10 ft.)	15 mm (5/8 inch)
200 - 300 mm (8 - 12 inch)	4.25 m (14 ft.)	22 mm (7/8 inch)
350 and over mm (14 and over inch)	6 m (20 ft.)	25 mm (1 inch)
PVC (All Sizes)	1.8 m (6 ft.)	9 mm (3/8 inch)

END OF SECTION

Part 1 - General

1.1 SUMMARY

.1 Section Includes: Heat tracing cables for pipes including controls and installation.

.2 Related Requirements:

.1 Division 26 - Electrical

1.2 ACTION & INFORMATIONAL SUBMITTALS

.1 Product Data: Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Instructions: submit manufacturer's installation instructions.

Part 2 - Products

2.1 SYSTEM COMPONENTS

.1 All heating cable components shall be of Raychem manufacture and approved for the appropriate application.

2.2 PIPE FREEZE PROTECTION CABLES

.1 Self-regulating heating cables consisting of two (2) 16 AWG nickel-coated copper bus wires embedded in a self-regulating polymer core that varies its power output to respond to temperature along its length, allowing the heating cable to be cut to length in the field. Confirm exact length on site prior to cutting. The heating cable shall incorporate a braid of tinned copper grounding member and be covered by a radiation-crosslinked, modified polyolefin dielectric jacket.

.1 Type A: Raychem "XL Trace" 5XL1-CR, 5W/ft (16W/m), 120V -1 phase

.2 Type B: Raychem "XL Trace" 8XL1-CR, 8W/ft (26W/m), 120V -1 phase

2.3 SYSTEM CONTROL

.1 Unless noted otherwise, each cable system shall be controlled by an ambient sensing thermostat, Raychem #EC-TS complete with RTD wiring. Set temperature to 5°C.

.2 Where indicated, cable systems shall be controlled by a controller and remote RTDs. Controller shall be complete with a set of dry output "Loss of Power" relay contacts for connection to the Fire Alarm System. Raychem #C910 Series Controller and #RTD200 & RTD10CS-EN Series

2.4 ACCESSORIES

.1 RayClic power connections, tee kits and end seal components as required by each application.

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 Confirm installed diameters and lengths of pipes that are to be traced and arrange for cable manufacturer to confirm cable selections and reselect, as required.

.2 Install cables in accordance with manufacturer's recommendations and as indicated on Drawings prior to installation of pipe insulation.

.3 Install cables on full length of exposed pipe including all runouts and extend through roof into interior space.

.4 Apply "Electric Traced" labels to the outside of the thermal insulation.

.5 Arrange for Division 26 to make all power, control and fire alarm system connections. Breakers serving cables shall be 30 mA, GFCI type.

.6 Locate power connections, thermostats and controllers in accessible locations.

3.3 **HEAT TRACING CABLE TRACING SCHEDULE**

.1 Refer to Drawings.

3.4 **FIELD QUALITY CONTROL**

.1 Tests: Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Use 500 V Megger to test cables for continuity and insulation value and record readings before, during and after installation.

.3 Where resistance of 20 megohms or less is measured, stop work and advise Consultant.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Inertia bases.

.2 Vibration isolation.

1.2 RELATED SECTIONS

.1 Section 03 30 00 - Cast-in-Place Concrete: Placement of isolators in floating floor slabs, Supply of concrete for placement by this section.

.2 Section 23 05 16 - Piping Expansion Compensation.

.3 Section 23 05 29 - Supports and Anchors.

.4 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 PERFORMANCE REQUIREMENTS

.1 Provide vibration isolation on motor driven equipment over 0.35 kW (0.5 HP), plus connected piping and ductwork.

.2 Provide minimum static deflection of isolators for equipment as indicated.

.1 Upper Floors:

.1 600 - 800 rpm: 90 mm (3.5 inch).

.2 800 - 900 rpm: 50 mm (2 inch).

.3 1100 - 1500 rpm: 25 mm (1 inch).

.4 Over 1500 rpm: 12 mm (0.5 inch).

.3 Consider upper floor locations critical unless otherwise indicated.

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide schedule of vibration isolator type with location and load on each.

.3 Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Indicate special procedures and setting dimensions.

.3 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.6 CLOSEOUT SUBMITTALS

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of hangers including attachment points.

Part 2 - Products

2.1 **MANUFACTURERS**

.1 Acceptable Manufacturers:

.1 Vibro Acoustics

.2 Vibron

.3 E.H. Price

2.2 **VIBRATION ISOLATORS**

.1 **Open Spring Isolators:**

.1 Spring Isolators:

.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

.2 Code: Colour code springs for load carrying capacity.

.2 Springs: Minimum horizontal stiffness equal to 75% vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

.3 Spring Mounts: Provide with levelling devices, minimum 6 mm (1/4 inch) thick neoprene sound pads, and zinc chromate plated hardware.

.4 Sound Pads: Size for minimum deflection of 1.2 mm (1/16 inch); meet requirements for neoprene pad isolators.

.2 **Restrained Spring Isolators:**

.1 Spring Isolators:

.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

.2 Code: Colour code springs for load carrying capacity.

.2 Springs: Minimum horizontal stiffness equal to 75% vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

.3 Spring Mounts: Provide with levelling devices, minimum 6 mm (1/4 inch) thick neoprene sound pads, and zinc chromate plated hardware.

.4 Sound Pads: Size for minimum deflection of 1.2 mm (1/16 inch); meet requirements for neoprene pad isolators.

.5 Restraint: Provide heavy mounting frame and limit stops.

.3 **Closed Spring Isolators:**

.1 Spring Isolators:

.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

.2 Code: Colour code springs for load carrying capacity.

.2 Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.

.3 Springs: Minimum horizontal stiffness equal to 75% vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

.4 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 6 mm (1/4 inch) clearance.

.4 **Restrained Closed Spring Isolators:**

.1 Spring Isolators:

.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

.2 Code: Colour code springs for load carrying capacity.

.2 Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.

.3 Springs: Minimum horizontal stiffness equal to 75% vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

.4 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 6 mm (1/4 inch) clearance and limit stops.

.5 **Spring Hanger:**

.1 Spring Isolators:

.1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.

.2 Code: Colour code springs for load carrying capacity.

.2 Springs: Minimum horizontal stiffness equal to 75% vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

.3 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators rubber hanger with threaded insert.

.4 Misalignment: Capable of 20 degree hanger rod misalignment.

.6 **Neoprene Pad Isolators:**

.1 Rubber or neoprene waffle pads:

.1 30 durometer.

.2 Minimum 13 mm (1/2 inch) thick.

.3 Maximum loading 275 kPa (40 psi).

.4 Height of ribs: maximum 0.7 times width.

.2 Configuration: Single layer.

.3 Configuration: 13 mm (1/2 inch) thick waffle pads bonded each side of 6 mm (1/4 inch) thick steel plate

.7 **Glass Fibre Pads:** Neoprene jacketed pre-compressed moulded glass fibre.

.8 **Rubber Mount or Hanger:** Moulded rubber designed for 13 mm (0.5 inches) deflection with threaded insert.

.9 **Seismic Snubbers:**

.1 Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.

.2 Neoprene Elements: Replaceable, minimum of 18 mm (0.75 inch) thick.

.3 Capacity: 4 times load assigned to mount groupings at 10 mm (0.4 inch) deflection.

.4 Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Install isolation for motor driven equipment.

.3 **Bases:**

.1 Set steel bases for 25 mm (1 inch) clearance between housekeeping pad and base.

.2 Set concrete inertia bases for 50 mm (2 inch) clearance between housekeeping pad and base.

.3 Adjust equipment level.

.4 Install spring hangers without binding.

.5 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

.6 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

.7 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa (6 inch) static pressure, and on hanger supported, horizontally mounted axial fans.

.8 Support piping connections to isolated equipment resiliently for scheduled distance to nearest flexible pipe connector as follows.

.1 Up to 100 mm (4 inch) Diameter: First three points of support.

.2 125 to 200 mm (5 to 8 inch) Diameter: First four points of support.

.3 Select three hangers closest to vibration source for minimum 25 mm (1.0 inch) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 25 mm (1.0 inch) static deflection or 1/2 static deflection of isolated equipment.

.9 Connect wiring to isolated equipment with flexible hanging loop.

3.2 **EQUIPMENT REQUIRING VIBRATION ISOLATION**

.1 Provide vibration isolation for the following equipment:

.1 Exhaust fans over 1/2 HP

.2 Dehumidifier

.3 Energy Recovery Unit

.4 VRF indoor and outdoor Condensing units

.5 CO_2 Domestic water heat pump

3.3 **MANUFACTURER'S FIELD SERVICES**

.1 Prepare and start components.

.2 Inspect isolated equipment after installation and submit report. Include static deflections.

3.4 **PIPE ISOLATION SCHEDULE**

PIPE SIZE	ISOLATED DISTANCE FROM EQUIPMENT
25 mm (1 inch)	120 diameters (3.0 m (10 ft.))

PIPE SIZE	ISOLATED DISTANCE FROM EQUIPMENT
50 mm (2 inches)	90 diameters (4.5 m (15 ft.))
75 mm (3 inches)	80 diameters (6.0 m (20 ft.))
100 mm (4 inches)	75 diameters (7.5 m (25 ft.))
150 mm (6 inches)	60 diameters (9.0 m (30 ft.))
200 mm (8 inches)	60 diameters (12.0 m (40 ft.))
250 mm (10 inches)	54 diameters (13.5 m (45 ft.))
300 mm (12 inches)	50 diameters (15.0 m (50 ft.))
400 mm (16 inches)	45 diameters (18.0 m (60 ft.))
600 mm (24 inches)	38 diameters (23.0 m (75 ft.))
Over 600 mm (24 inches)	

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Nameplates.

.2 Tags.

.3 Stencils.

.4 Pipe Markers.

1.2 RELATED SECTIONS

.1 Section 09 91 22 - Painting: Identification painting.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASME A13.1 - Scheme for the Identification of Piping Systems.

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide manufacturers catalogue literature for each product required.

.3 Identification Information:

.1 Submit list of wording, symbols, letter size, and colour coding for mechanical identification.

.2 Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Indicate special procedures, and installation.

1.6 CLOSEOUT SUBMITTALS

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of tagged valves.

Part 2 - Products

2.1 NAMEPLATES

.1 Manufacturers:

.1 Seton

.2 Brimar

.3 Brady

.2 Description: Laminated three-layer plastic with engraved black letters on light contrasting background colour.

2.2 **TAGS**

.1 Manufacturers:

.1 Seton

.2 Brimar

.3 Brady

.2 Metal Tags: Aluminum with stamped letters; round tags, with smooth edges.

.3 Chart: Typewritten letter size list in anodized aluminum frame. Locate in Mechanical Room.

2.3 **STENCILS**

.1 Manufacturers:

.1 Seton

.2 Brimar

.3 Brady

.2 Stencils: With clean cut symbols and letters of following size:

.1 20 to 30 mm (3/4 to 1-1/4 inch) Outside Diameter of Insulation or Pipe: 200 mm (8 inch) long colour field, 15 mm (1/2 inch) high letters.

.2 40 to 50 mm (1-1/2 to 2 inch) Outside Diameter of Insulation or Pipe: 200 mm (8 inch) long colour field, 20 mm (3/4 inch) high letters.

.3 65 to 150 mm (2-1/2 to 6 inch) Outside Diameter of Insulation or Pipe: 300 mm (12 inch) long colour field, 30 mm (1-1/4 inch) high letters.

.4 200 to 250 mm (8 to 10 inch) Outside Diameter of Insulation or Pipe: 600 mm (24 inch) long colour field, 65 mm (2-1/2 inch) high letters.

.5 Over 250 mm (10 inch) Outside Diameter of Insulation or Pipe: 800 mm (32 inch) long colour field, 90 mm (3-1/2 inch) high letters.

.6 Ductwork and Equipment: 65 mm (2-1/2 inch) high letters.

2.4 **PIPE MARKERS**

.1 Manufacturers:

.1 Seton

.2 Brimar

.3 Brady

.2 Colour: Conform to ASME A13.1.

.3 Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

.4 Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

.5 Underground Plastic Pipe Markers: Bright coloured continuously printed plastic ribbon tape, minimum 150 mm (6 inches) wide by 0.10 mm (4 mil) thick, manufactured for direct burial service.

2.5 **CEILING TACKS**

.1 Description: Steel with 20 mm (3/4 inch) diameter colour coded head.

.2 Colour code as follows:

.1 Yellow - HVAC equipment.

.2 Red - Fire dampers/smoke dampers.

.3 Green - Plumbing valves.

.4 Blue - Heating valves.

Part 3 - Execution

3.1 **PREPARATION**

.1 Degrease and clean surfaces to receive adhesive for identification materials.

.2 Prepare surfaces to Section 09 91 22 for stencil painting.

3.2 **INSTALLATION**

.1 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

.2 Install tags with corrosion resistant chain.

.3 Apply stencil painting to Section 09 91 22.

.4 Install plastic pipe markers to manufacturer's written instructions.

.5 Install plastic tape pipe markers complete around pipe to manufacturer's written instructions.

.6 Install underground plastic pipe markers 150 to 200 mm (6 to 8 inches) below finished grade, directly above buried pipe.

.7 Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with stencil painting. Small devices, such as in-line pumps, may be identified with tags.

.8 Identify control panels and major control components outside panels with plastic nameplates.

.9 Identify thermostats relating to terminal boxes or valves with nameplates.

.10 Identify valves in main and branch piping with tags.

.11 Identify air terminal units and radiator valves with numbered tags.

.12 Tag automatic controls, instruments, and relays. Key to control schematic.

.13 Identify piping, concealed or exposed, with stencilled painting. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m (20 ft) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

.1 Use tags on piping 20 mm (3/4 inch) diameter and smaller.

.2 Identify service, flow direction, and pressure. Install in clear view and align with axis of piping.

.3 Locate identification not to exceed 6 m (20 ft) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

.14 Identify ductwork with stencilled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

.15 Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Testing, adjustment, and balancing of air systems.

.2 Testing, adjustment, and balancing of hydronic, steam, refrigerating systems.

.3 Measurement of final operating condition of HVAC systems.

.4 Sound measurement of equipment operating conditions.

.5 Vibration measurement of equipment operating conditions.

1.2 RELATED SECTIONS

.1 Section 01 45 23 - Testing & Inspection Services:

.1 Testing laboratory services.

.2 Employment of testing agency and payment for services.

.3 Inspection and testing allowances.

.2 Section 01 78 00 - Closeout Submittals:

.1 Starting of Systems.

.2 Testing, Adjusting, and Balancing of Systems.

1.3 PRICE & PAYMENT PROCEDURES

.1 The General Contractor shall carry an allowance to engage a testing company specializing in this Work. The Work will be tendered at a later date.

1.4 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 AABC-2002 - National Standards for Total System Balance.

.4 ADC 1062: GRD-84 - Test Code for Grilles, Registers and Diffusers.

.5 NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Submit name of adjusting and balancing agency for approval within thirty (30) days after award of Contract.

.3 Field Reports: Submit procedures for submitting Field Reports.

.1 Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

.2 Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

.3 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Consultant and for inclusion in operating and maintenance manuals.

.4 Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

.5 Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

.4 Test Reports: Indicate data on AABC National Standards for Total System Balance forms.

1.6 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of flow measuring stations balancing valves and rough setting.

1.7 **QUALITY ASSURANCE**

.1 Perform total system balance to AABC National Standards for Field Measurement and Instrumentation, Total System Balance and NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

.2 Maintain one (1) copy of document on site.

.3 Agency Qualifications: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three (3) years documented experience certified by AABC.

.4 Perform Work under supervision of AABC Certified Test and Balance Engineer NEBB Certified Testing, Balancing and Adjusting Supervisor and registered Professional Engineer experienced in performance of this Work and licensed at the place where the Project is located.

Part 2 - Products

2.1 **NOT USED**

Part 3 - Execution

3.1 **PRIME MECHANICAL CONTRACTOR RESPONSIBILITY**

.1 Provide to the Testing Agency a set of Mechanical Drawings, Specifications, all Addenda and Change Orders, and Shop Drawings of all equipment to be tested and balanced.

.2 Supply and install all balancing devices where required by the testing agency.

.3 Provide to the testing agency a set of all Approval Drawings reviewed by the Consultant with wiring diagrams.

.4 The respective trades shall provide a journeyman, tools, ladders and scaffolding to assist the Balancing and Testing Agency. He shall open and replace ceilings and install additional devices such as baffles, dampers, valves, etc., as required and requested. Sheave and belt changes to be supplied and installed by Division 15 as required by the Testing Agency. Pump impeller changes/modifications to be supplied and installed by the Prime Mechanical Contractor as required by the Testing Agency.

.5 The Monitoring & Control System shall check all control operation before balancing and testing is started. Assist the Balancing and Testing Agency in final adjustment of air and water systems to provide comfortable space conditions.

.6 Prime Mechanical Contractor shall be in charge of the plant during tests. He shall assume responsibility for damages in the event of injury to the personnel, building or equipment, and shall bear all costs for liability, repairs and restoration in this connection.

.7 Coordinate air and water balancing with the Commissioning Agent.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Duct work insulation.

.2 Duct Liner.

.3 Insulation jackets.

1.2 RELATED SECTIONS

.1 Section 09 91 22 - Painting: Painting insulation jackets.

.2 Section 23 05 53 - Mechanical Identification.

.3 Section 23 31 00 - Duct Work: Glass fibre duct work.

.4 Section 23 31 00 - Duct Work: Duct liner.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.4 ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.5 ASTM B210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.

.6 ASTM B210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.

.7 ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.8 ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.9 ASTM C612 - Standard Specification for Mineral Fiber Block and Board Insulation.

.10 ASTM E84-15a - Standard Test Method for Surface Burning Characteristics of Building Materials.

.11 ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

.12 NAIMA - National Insulation Standards.

.13 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials

.14 SMACNA 1966-2005 - HVAC Duct Construction Standards - Metal and Flexible

.15 UL 723-2008 - Tests for Surface Burning Characteristics of Building Materials

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

.3 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and approved by the manufacturer.

1.7 **REGULATORY REQUIREMENTS**

.1 Materials: Flame spread/smoke developed rating of 25/50 to ASTM E84 and UL 723.

1.8 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

.3 Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.9 **SITE CONDITIONS**

.1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

.2 Maintain temperature during and after installation for minimum period of twenty-four (24) hours.

Part 2 - Products

2.1 **GLASS FIBRE, FLEXIBLE**

.1 **Insulation:** ASTM C553; flexible, non-combustible blanket.

.1 Thermal Conductivity: 0.036 W /m.K at 24 degrees C (0.25 BTU.in/h.sq. ft. at 75 degrees F).

.2 Maximum service temperature: 176 degrees C (350 degrees F).

.3 Maximum moisture absorption: 0.20% by volume.

.2 **Vapour Barrier Jacket:** [Kraft paper with glass fibre yarn and bonded to aluminized film] [Vinyl].

.1 Moisture vapour transmission: ASTM E96/E96M; 0.02 perm.

.2 Secure with pressure sensitive tape.

.3 **Vapour Barrier Tape:**

.1 Kraft paper reinforced with glass fibre yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

.4 **Outdoor Vapour Barrier Mastic:**

.1 Vinyl emulsion type acrylic or mastic, compatible with insulation, black colour.

.5 Tie Wire: Annealed steel, 1.5 mm (16 ga).

2.2 **GLASS FIBRE, RIGID**

.1 **Insulation:** ASTM C612; rigid, non-combustible blanket.

.1 Thermal Conductivity: ASTM C518, 0.036 W/m.K at 24 degrees C (0.25 BTU.in/h.sq. ft. at 75 degrees F).

.2 Maximum service temperature: 121 degrees C (250 degrees F).

.3 Maximum moisture absorption: 0.20% by volume.

.4 Density: [48 kg/cu. m (3.0 lb/cu. ft.)] [72 kg/cu. m (4.5 lb/cu. ft.)].

.2 **Vapour Barrier Jacket:** [Kraft paper with glass fibre yarn and bonded to aluminized film] [Vinyl].

.1 Moisture vapour transmission: ASTM E96/E96M; 0.04 perm.

.2 Secure with [pressure sensitive tape] [two (2) coats of vapour barrier mastic and glass tape].

.3 **Indoor Vapour Barrier Finish:**

.1 Cloth: Untreated; 305 g/sq. m (9 oz./sq. yd.) weight, glass fabric.

.2 Vinyl emulsion type acrylic, compatible with insulation, [black] [white] colour.

2.3 **JACKETS**

.1 **Canvas Jacket:** UL listed.

.1 Fabric: ASTM C921, 220 g/sq. m (6 oz./sq. yd.) plain weave cotton treated with dilute fire retardant lagging adhesive.

.2 Lagging Adhesive:

.1 Compatible with insulation.

.2 **Mineral Fibre (Outdoor) Jacket:** Asphalt impregnated and coated sheet, [2.45 kg/sq. m (50 lb/square)] [1.76 kg/sq. m (36 lb/square)].

.3 **Aluminum Jacket:** ASTM B209M (ASTM B209).

.1 Thickness: 0.50 mm (0.020 inch) sheet.

.2 Finish: Smooth.

.3 Joining: Longitudinal slip joints and 50 mm (2 inch) laps.

.4 Fittings: 0.40 mm (0.016 inch) thick die shaped fitting covers with factory attached protective liner.

.5 Metal Jacket Bands: wide 0.25 mm (0.010 inch) thick aluminum.

2.4 **GLASS FIBRE DUCT LINER, FLEXIBLE**

.1 **Insulation:** ASTM C1071; flexible, non-combustible blanket with acrylic polymer meeting ASTM G2 impregnated surface and edge coat.

.1 Thermal Conductivity: Maximum 0.039 W/m.K at 24 degrees C (0.27 BTU.in/h.sq. ft. at 75 degrees F).

.2 Maximum service temperature: 176 degrees C (350 degrees F).

.3 Maximum Velocity on Coated Air Side: 25.4 m/s (5,000 fpm).

.4 Minimum Noise Reduction Criteria: ASTM C1071, 0.45 for 40 mm (1-1/2 inch) thickness.

.2 **Adhesive:**

.1 Type: ASTM E162, fire-retardant.

.3 **Liner Fasteners:** Galvanized steel, self-adhesive pad with integral head.

2.5 **GLASS FIBRE DUCT LINER, RIGID**

.1 **Insulation:** ASTM C612; rigid, non-combustible board with acrylic polymer meeting ASTM G21 impregnated surface and edge coat.

.1 Thermal Conductivity: 0.037 W/m.K at 24 degrees C (0.27 BTU.in/h.sq. ft. at 75 degrees F) maximum.

.2 Maximum service temperature: 176 degrees C (350 degrees F).

.3 Maximum Velocity on Coated Air Side: 25.4 m/s (5000 fpm).

.4 Minimum Noise Reduction Criteria: ASTM C1071, 0.55 for 40 mm (1-1/2 inch) thickness.

.2 **Adhesive:**

.1 Type: ASTM E162, fire-retardant.

.3 **Liner Fasteners:** Galvanized steel, self-adhesive pad with integral head.

2.6 **GLASS FIBRE ROUND DUCT LINER**

.1 **Insulation:** Round, preformed in cylindrical sections with acrylic polymer meeting ASTM G21 impregnated surface coat.

.1 Thermal Conductivity: ASTM C1071, 0.039 W/m.K at 24 degrees C (0.27 BTU.in/h.sq. ft. at 75 degrees F), maximum.

.2 Maximum service temperature: 176 degrees C (350 degrees F).

.3 Maximum Velocity on Coated Air Side: 25.4 m/s (5000 fpm).

2.7 **FIRE SEPARATIONS**

.1 Where ducts pass through fire separations (walls, floor and partitions) pack space with ULC listed and/or approved fire stopping mineral fibre insulation and seal with approved fire-retardant sealing compounding. Sealing compound to be installed to Manufacturer's Specifications and detail. Fire stopping shall comply with the Ontario Building Code and approved by local Building Department. Obtain written approval from Local Building Department before commencing with Work.

.2 It is the responsibility of this Division to determine the locations of all fire separations, as shown on the Architectural Contract Documents.

.3 Pipes complete with insulation, passing through a fire rated separation must be complete with fire stop mineral wool insulation type RXL-Safe as supplied by ROXUL Inc. Sealant shall be Fyre-Sil for vertical separations and Fyre-Sil SL for horizontal separations. Insulation shall extend a minimum 600 mm (24") beyond face, both sides of the separation.

2.8 **DUCTWORK**

.1 External (Rigid) Larger than 17" x 13" (425 mm x 325 mm): Fibreglass rigid vapour seal type (AF530) 3.0 PCF (48 kg/m^3) in exposed areas finish with 8 oz. (227 gm) canvas adhered with welding pins on 12" (305 mm) to 18" (457 mm) centres, secured with clips. Apply to outside of ductwork. (Min R - Value of 4.0/in.).

.2 External (Flexible) Up to 16" x 12" (400 mm x 300 mm): Fibreglass all service faced flexible duct insulation 0.75 PCF (12 kg/m³) with factory applied reinforced foil facing. In exposed areas finish with 8 oz. (227 gm) canvas, adhere with fire retardant adhesive, applied in strips 6" (150 mm) wide and 12" (305 mm) on centres applied to outside of ductwork. (Min R-Value of 2.5/in).

.3 Internal (Acoustic Duct Liner): 1" (25 mm) thick fibreglass duct liner or thickness as indicated, with neoprene coating. Adhere with minimum 50% covering of fire retardant adhesive, and supplement with welding pins. (Min R - Value of 4.0/in.). Designated on Drawings by diagonal hatching or where noted.

2.9 **EXPOSED DUCTWORK INSIDE**

.1 All exposed ductwork located in Mechanical Rooms, etc., shall be canvas covered with 6 oz. (0.17 kg) fireproof canvas, complete with two coats Bakor #120-18.

.2 Exterior insulation is not required where interior sound insulation is installed.

2.10 **PLENUMS**

.1 Insulate plenums with insulation board, 2" (50 mm) thick, 6.0 lb/ft³ (96 kg/m³) density.

.2 Seal all breaks with Bakor. Cover with foil-faced tape.

.3 All insulation shall be secured to flat sheet metal surface by means of welded pins or perforated base metal fasteners adhered with Bakor #230-35 and speed washers. These shall be located on maximum 12" (300 mm) centres. When the insulation has been placed on the metal spike, the speed washers shall be attached, and the excess spike cut off flush with the washer. Corners of insulation shall be Provided with a preformed, protective edge applied to insulation before canvassing.

.4 On completion, surfaces shall be canvas covered with 6 oz. (.17 kg) fireproof canvas and finished with two (2) coats of Bakor #120-09.

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verify existing conditions before starting work.

.2 Verify that duct work has been tested before applying insulation materials.

.3 Verify that surfaces are clean, foreign material removed, and dry.

3.2 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Insulated duct work conveying air below ambient temperature:

.1 Provide insulation with vapour barrier jackets.

.2 Finish with tape and vapour barrier jacket.

.3 Continue insulation through walls, sleeves, hangers, and other duct penetrations.

.4 Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

.3 Insulated duct work conveying air above ambient temperature:

.1 Provide with or without standard vapour barrier jacket.

.2 Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

.4 Duct Work Exposed in Mechanical Equipment Rooms or Finished Spaces below 3 m (10 ft.) above finished floor: Finish with canvas jacket sized for finish painting.

.5 **External Duct Insulation Application:**

.1 Secure insulation with vapour barrier with wires and seal jacket joints with vapour barrier adhesive or tape to match jacket.

.2 Secure insulation without vapour barrier with staples, tape, or wires.

.3 Install without sag on underside of duct work. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct work off trapeze hangers and insert spacers.

.4 Seal vapour barrier penetrations by mechanical fasteners with vapour barrier adhesive.

.5 Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

.6 **Duct Liner Application:**

.1 Adhere insulation with adhesive for 100% coverage.

.2 Secure insulation with mechanical liner fasteners. Refer to SMACNA 1966 Standards for spacing.

.3 Seal and smooth joints. Seal and coat transverse joints.

.4 Seal liner surface penetrations with adhesive.

.5 Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 EXTENT OF DUCT INSULATION

.1 Insulate all supply air ductwork from the fan outlet to the diffuser outlet connection as follows:

.1 Air intake plenum and exhaust air plenums

.2 All grille/diffuser supply air plenums, boxes or boots

.3 Exhaust ductwork from 6'-0" (1800 mm) from outside wall.

.4 Supply ductwork serving VRF fan coils.

.5 Supply and return ductwork serving all ERV Units

.2 Do not insulate; except as noted otherwise:

.1 Exhaust ductwork

.2 Pre-insulated flexible ducts

.3 Acoustically-lined ductwork (except on roof where acoustically lined ducts shall also have thermal insulation)

3.4 ACOUSTIC DUCT LINER

.1 By Sheet Metal Contractor.

.2 Sheet Metal Contractor shall acoustically line all VRF fan coil supply ductwork and individual transfer boots.

3.5 PLENUMS

.1 Insulate outdoor air plenums on warm side of sheet metal wall.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Equipment insulation.

.2 Covering.

.3 Breeching insulation.

1.2 RELATED SECTIONS

.1 Section 09 91 22 - Painting: Painting insulation covering.

.2 Section 23 05 53 - Mechanical Identification.

.3 Section 22 10 00 - Plumbing Piping: Placement of hangers and hanger inserts.

.4 Section 23 21 00 - Hydronic Piping: Placement of hangers and hanger inserts.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.4 ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.5 ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.6 ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

.7 ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

.8 ASTM C240 - Standard Test Methods of Testing Cellular Glass Insulation Block.

.9 ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

.10 ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

.11 ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

.12 ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

.13 ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.

.14 ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.15 ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).

.16 ASTM C612 - Standard Specification for Mineral Fiber Block and Board Insulation.

.17 ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.18 ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

.19 ASTM E84-15a - Standard Test Method for Surface Burning Characteristics of Building Materials.

.20 ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

.21 NAIMA - National Insulation Standards.

.22 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials

.23 UL 723-2008 - Tests for Surface Burning Characteristics of Building Materials

1.4 **SUBMITTALS FOR REVIEW**

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

.3 Samples: Submit two (2) samples of any representative size illustrating each insulation type.

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

.3 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience and approved by the manufacturer.

1.7 **REGULATORY REQUIREMENTS**

.1 Materials: Flame spread/smoke developed rating of 25/50 to ASTM E84 and NFPA 255.

1.8 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

.3 Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.9 **SITE CONDITIONS**

.1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

.2 Maintain temperature during and after installation for minimum period of twenty-four (24) hours.

Part 2 - Products

2.1 **GLASS FIBRE, FLEXIBLE**

.1 **Calcium Silicate Insulation:** ASTM C553, Type II - pipe, preformed, high temperature insulation.

.1 Thermal Conductivity (k-factor): 0.035 W/m.K at 24 degrees C (0.24 BTU.in/h.sq. ft. at 75 degrees F).

.2 Maximum Service Temperature: 121 degrees C (250 degrees F).

.3 Maximum Moisture Absorption: 0.2% by volume.

.4 Density: 16 kg/cu. m (1 lb/cu. ft.)

.2 **Vapour Barrier Jacket:**

.1 ASTM C921

.2 Moisture vapour transmission: ASTM E96/E96M, 0.04 perm.

.3 Secure with self-sealing longitudinal laps and butt strips.

.4 Secure with outward clinch expanding staples and vapour barrier mastic.

.3 **Tie Wire:** 1.22 mm (0.048 inch) stainless steel with twisted ends on maximum 300 mm (12 inch) centres.

.4 **Vapour Barrier Lap Adhesive:** compatible with insulation.

.5 **Insulating Cement/Mastic:** STM C195, hydraulic setting on mineral wool.

2.2 **GLASS FIBRE, RIGID**

.1 **Insulation:** ASTM C612, rigid, non-combustible.

.1 Thermal Conductivity (k-factor): ASTM C177, 0.035 W/m.K degrees C (0.24 BTU.in/h.sq. ft. at 75 degrees F).

.2 Maximum Service Temperature: 232 degrees C (450 degrees F), 343 degrees C (650 degrees F) or 454 degrees C (850 degrees F), as applicable to the application

.3 Maximum Moisture Absorption: 0.1% by volume.

.4 Density: 16 kg/cu. m (1.0 lb/cu. ft.).

.2 **Vapour Barrier Jacket:**

.1 Kraft paper reinforced with glass fibre yarn and bonded to aluminized film.

.2 Moisture vapour transmission: ASTM E96/E96M, 0.02 perm.

.3 Secure with self-sealing longitudinal laps and butt strips.

.4 Secure with outward clinch expanding staples and vapour barrier mastic.

.3 **Facing:** 25 mm (1 inch), hexagonal wire mesh stitched on one (1) face of insulation with expanded metal lath on other.

.4 **Vapour Barrier Lap Adhesive:** compatible with insulation.

.5 **Insulating Cement/Mastic:** ASTM C195, hydraulic setting on mineral wool.

2.3 **CELLULAR GLASS**

.1 **Insulation:** ASTM C552.

.1 Thermal Conductivity (k-factor): 0.039 W/m.K at 24 degrees C (0.35 BTU.in/h.sq. ft. at 75 degrees F).

.2 Maximum Service Temperature: 482 degrees C (900 degrees F).

.3 Maximum Water Vapour Transmission: 0.1 or 0.00 perm, as applicable to the application.

.4 Maximum Moisture Absorption: ASTM C240, 0.2% by volume.

.5 Density: 128 kg/cu. m (8.0 lb/cu. ft.).

2.4 **HYDROUS CALCIUM SILICATE**

.1 **Insulation:** ASTM C533; rigid moulded, asbestos free, gold colour.

.1 Thermal Conductivity (k-factor): ASTM C177 ASTM C518; 0.057 W/m.K at 148 degrees C (0.40 BTU.in/h.sq. ft. at 75 degrees F).

.2 Maximum Service Temperature: 649 degrees C (1200 degrees F).

.3 Density: 249 kg/cu. m (15 lb/cu. ft.).

.2 **Tie Wire:** 1.22 mm (0.048 inches) stainless steel with twisted ends on maximum 300 mm (12 inch) centres.

.3 **Insulating Cement:** ASTM C449.

2.5 **CELLULAR FOAM**

.1 **Insulation:** ASTM C534/C534M; flexible, cellular elastomeric, moulded or sheet.

.1 Thermal Conductivity (k-factor): ASTM C177; 0.032 W/m.K at 24 degrees C (0.25 BTU.in/h.sq. ft. at 75 degrees F).

.2 Minimum Service Temperature: -40 degrees C (-40 degrees F).

.3 Maximum Service Temperature: 104 degrees C (220 degrees F).

.4 Maximum Moisture Absorption: ASTM D1056; 1.0% by volume.

.5 Moisture Vapour Transmission: ASTM E96/E96M, 0.05 perm-inches.

.6 Connection: Waterproof vapour barrier adhesive.

.2 **Elastomeric Foam Adhesive:** Air dried, contact adhesive, compatible with insulation.

2.6 **JACKETS**

.1 **PVC Plastic Jacket:** ASTM C921, Sheet material, off-white colour.

.1 Minimum Service Temperature: -40 degrees C (-40 degrees F).

.2 Maximum Service Temperature: 66 degrees C (150 degrees F).

.3 Moisture Vapour Transmission: ASTM E96/E96M, 0.002 perm-inches.

.4 Thickness: 0.375 mm (15 mil).

.5 Connections: Pressure sensitive colour matching vinyl tape, Brush on welding adhesive or Tacks, as applicable to the application.

.6 Covering Adhesive Mastic: compatible with insulation.

.2 **Canvas Jacket:** UL listed.

.1 Fabric: ASTM C921, 220 g/sq. m (6 oz./sq. yd.), plain weave cotton treated with dilute fire retardant lagging adhesive.

.2 Lagging Adhesive: compatible with insulation.

.3 **Aluminum Jacket:** ASTM B209M (ASTM B209).

.1 Thickness: 0.50 mm (0.020 inch) sheet.

.2 Finish: Embossed.

.3 Joining: Longitudinal slip joints and 50 mm (2 inch) laps.

.4 Metal Jacket Bands: 0.25 mm (0.010 inch) thick aluminum.

2.7 **WATER METERS**

.1 Insulation blanket shall be resilient, inorganic glass fibres bonded by a thermosetting resin complete with vinyl vapour retarder.

.2 Insulate with two (2) separate layers of 1" (25 mm) thick, 1.5 lb/ft³ (24 kg/m³) density. Provide vapour barrier of 1 mil aluminum foil wrapped together over the insulation, with all laps sealed with vapour seal mastic. Cover with 1/4" (8 mm) wet coat of vapour seal mastic into which glass fabric shall be embedded. Finish with insulating cement and canvas.

2.8 **OTHER EQUIPMENT**

.1 The following equipment shall be insulated:

.1 Storage tank - Designated ST-1

.2 Hydronic Air Separator - Designated AS-1

.3 Hydronic circulating pumps - Designated HP-1 and HP-1A

.4 Domestic recirculation pump - Designated P-1

.5 Central thermostatic mixing valve station

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verify existing conditions before starting work.

.2 Verify that equipment has been tested before applying insulation materials.

.3 Verify that surfaces are clean and dry, with foreign material removed.

3.2 **INSTALLATION**

.1 Install components to manufacturer's written instructions.

.2 Factory Insulated Equipment: Do not insulate.

.3 Exposed Equipment: Locate insulation and cover seams in least visible locations.

.4 Apply insulation close to equipment by grooving, scoring, and bevelling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

.5 Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapour barrier cement.

.6 Insulated equipment containing fluids below ambient temperature: Insulate entire system.

.7 Fibre glass insulated equipment containing fluids below ambient temperature: Provide vapour barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapour barrier adhesive.

.8 For hot equipment containing fluids [60 degrees C (140 degrees F)] or less, do not insulate flanges and unions, but bevel and seal ends of insulation.

.9 For hot equipment containing fluids over [60 degrees C (140 degrees F)], insulate flanges and unions with removable sections and jackets.

.10 Fibre glass insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapour barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

.11 **Inserts and Shields:**

.1 Application: Equipment 40 mm (1-1/2 inch) diameter or larger.

.2 Shields: Galvanized steel between hangers and inserts.

.3 Insert location: Between support shield and equipment and under the finish jacket.

.4 Insert configuration: Minimum 150 mm (6 inches) long, of same thickness and contour as adjoining insulation; may be factory fabricated.

.5 Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

.12 Finish insulation at supports, protrusions, and interruptions.

.13 Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with aluminum jacket.

.14 Exterior Applications: Provide vapour barrier jacket or finish with glass mesh reinforced vapour barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

.15 Cover cellular glass insulation with aluminum jacket.

.16 Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

.17 Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Piping insulation.

.2 Jackets and accessories.

1.2 RELATED SECTIONS

.1 Section 09 91 22 - Painting: Painting insulation jacket.

.2 Section 22 10 00 - Plumbing Piping: Placement of hangers and hanger inserts.

.3 Section 23 05 53 - Mechanical Identification.

.4 Section 23 21 00 - Hydronic Piping: Placement of hangers and hanger inserts.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.4 ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.5 ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

.6 ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

.7 ASTM C335/C335M-10e1 - Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.

.8 ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

.9 ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

.10 ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

.11 ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

.12 ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.

.13 ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.

.14 ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

.15 ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.

.16 ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

.17 ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.

.18 ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.19 ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

.20 ASTM D1667 - Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell).

.21 ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.

.22 ASTM E84-15a - Standard Test Method for Surface Burning Characteristics of Building Materials.

.23 ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

.24 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

.25 UL 723-2008 - Tests for Surface Burning Characteristics of Building Materials

1.4 **SUBMITTALS FOR REVIEW**

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide product description, list of materials and thickness for each service, and locations.

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Manufacturer's special installation requirements including procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Materials: Flame spread/smoke developed rating of 25/50 or less to NFPA 255.

.3 Applicator: Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience.

1.7 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

.3 Store insulation in original wrapping and protect from weather and construction traffic.

.4 Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 **SITE CONDITIONS**

.1 Ambient Conditions:

.1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

.2 Maintain temperature during and after installation for minimum period of twenty-four (24) hours.

Part 2 - Products

2.1 **GLASS FIBRE**

.1 **Insulation:** ASTM C547, rigid moulded, non-combustible.

.1 Thermal Conductivity (K-factor): ASTM C335/C335M, 0.035 W/m.K at 24 degrees C (0.24 BTU.in/h.sq. ft. at 75 degrees F).

.2 Minimum Service Temperature: -28.9 degrees C (-20 degrees F)

.3 Maximum Service Temperature: 232 degrees C (450 degrees F).

.4 Maximum Moisture Absorption: 0.2% by volume.

.2 **Vapour Barrier Jacket:**

.1 ASTM C921, White kraft paper reinforced with glass fibre yarn and bonded to aluminized film.

.2 Moisture Vapour Transmission: ASTM E96/E96M, 0.03 ng/(Pa s sq. m) (0.02 perm inches).

.3 Secure with self sealing longitudinal laps and butt strips.

.4 Secure with outward clinch expanding staples and vapour barrier mastic.

.3 **Tie Wire:** 1.3 mm (18 ga) stainless steel with twisted ends on maximum 300 mm (12 inch) centres.

.4 **Vapour Barrier Lap Adhesive:** Compatible with insulation.

.5 **Insulating Cement/Mastic:** ASTM C195, hydraulic setting on mineral wool.

.6 **Fibrous Glass Fabric:**

.1 Cloth: Untreated; 305 g/sq. m (9 oz./sq. yd.) weight.

.2 Blanket: 16 kg/cu m (1 lb/cu ft.) density.

.7 **Indoor Vapour Barrier Finish:** Vinyl emulsion type acrylic, compatible with insulation, white colour.

.8 **Outdoor Vapour Barrier Mastic:** Vinyl emulsion type acrylic, compatible with insulation, white colour.

.9 **Insulating Cement:** ASTM C449.

2.2 **CELLULAR GLASS**

.1 **Insulation:** ASTM C552.

.1 Thermal Conductivity (K-factor): 0.058 W/m.K at 24 degrees C (0.40 BTU.in/h.sq. ft. at 75 degrees F).

.2 Maximum Water Vapour Transmission: 0.1 perm.

2.3 **JACKETS**

.1 **PVC Plastic:**

.1 Jacket: ASTM C921, One-piece moulded type fitting covers and sheet material, off white colour.

.1 Minimum Service Temperature: -40 degrees C (-40 degrees F).

.2 Maximum Service Temperature: 66 degrees C (150 degrees F).

.3 Moisture Vapour Transmission: ASTM E96/E96M; 0.002 perm inches.

.4 Maximum Flame Spread: ASTM E84, 25.

.5 Maximum Smoke Developed: ASTM E84, 50.

.6 Thickness: 00.38 mm (15 mil), as applicable to the application.

.7 Connections: Brush on welding adhesive, Tacks or Pressure sensitive colour matching vinyl tape, as applicable to the application.

.2 Covering Adhesive Mastic: Compatible with insulation.

.2 **ABS Plastic:**

.1 Jacket: One-piece moulded type fitting covers and sheet material, off white colour.

.1 Minimum Service Temperature: -40 degrees C (-40 degrees F).

.2 Maximum Service Temperature of 82 degrees C (180 degrees F).

.3 Moisture Vapour Transmission: ASTM E96/E96M, 0.012 perm inches.

.4 Thickness: 0.76 mm (30 mil).

.5 Connections: Brush on welding adhesive.

.3 **Canvas Jacket:** UL listed.

.1 Fabric: ASTM C921, 220 g/sq. m (6 oz./sq. yd.), plain weave cotton treated with dilute fire retardant lagging adhesive.

.2 Lagging Adhesive: Compatible with insulation.

.4 **Aluminum Jacket:** ASTM B209M/B209.

.1 Thickness: 0.40 mm (0.016 inch) sheet.

.2 Finish: Embossed or Smooth, as applicable to the application.

.3 Joining: Longitudinal slip joints and 50 mm (2 inch) laps.

.4 Fittings: 0.40 mm (0.016 inch) thick die shaped fitting covers with factory attached protective liner.

.5 Metal Jacket Bands: 10 mm (3/8 inch) wide or 0.25 mm (0.010 inch) thick aluminum.

2.4 **MATERIALS**

.1 **Domestic Cold Water:**

.1 Piping: Fibreglass heavy density fibreglass insulation with factory applied all service vapour barrier jacket lapped and adhered with Flintkote 203 adhesive or equal. Insulation conductivity shall be in the range of 0.22 - 0.28 BTU in/(h.ft^3.°F) with mean temperature of 100°F. Seal all joints with 4" (100 mm) wide strip of all service jacket material. Finished with a smooth layer of asbestos free finishing cement and covered with canvas.

.2 Fittings and valves: Moulded or fabricated mitred segments of a thickness equal to that of the pipe insulation and finished with a layer of asbestos free finishing cement, trowelled smooth and covered with canvas.

.3 Alternative method for insulating fittings: Pre-moulded high impact PVC fitting covers with fibreglass inserts, end joints sealed with PVC tape.

.4 Exposed insulation: Finish with PVC vapour barrier jacket and adhere with cement adhesive. Seal all joints with 4" (100 mm) wide strip of PVC tape. Colour of tape to match PVC cover.

.5 Insulation shall be of thicknesses as follows:

Pipe Size	Insulation Thickness
1/2" (13 mm) - 1-1/4" (32 mm) ∅ pipe	1/2" (15 mm)
1-1/2" (40 mm) - 8" (200 mm) ∅ pipe	1" (25 mm)

.2 **Domestic Hot Water, Tempered, Domestic Hot Water Recirculation Piping:**

.1 Piping: Fibreglass heavy density fibreglass insulation with factory applied all service jacket lapped and adhered with Flintkote #203 adhesive or equal. Seal all joints with 4" (100 mm) wide strip of all service jacket material. Insulation conductivity shall be in the range of 0.22 - 0.28 BTU in/(h.ft^3.°F) with mean temperature of 100°F (38°C).

.2 Fittings and Valves: Moulded or fabricated mitred segments of a thickness equal to that of the pipe insulation and finished with a layer of asbestos free finishing cement, trowelled smooth and covered with canvas.

.3 Alternative method for insulating fittings: Pre-moulded high impact PVC fitting covers with fibreglass inserts, end joints sealed with PVC tape.

.4 Exposed Insulation: Finish with PVC vapour barrier jacket and adhere with cement adhesive. Seal all joints with 4" (100 mm) wide strip of PVC tape.

.5 Insulation shall be of thicknesses as follows:

Pipe Size	Insulation Thickness
1/2" (15 mm) - 1-1/4" (32 mm) ∅ pipe	1" (25 mm)
1-1/2" (40 mm) - 4" (100 mm) ∅ pipe	1-1/2" (40 mm)

.3 **Rainwater Leaders, Horizontal Storm Piping, Cold Condensate Piping:**

.1 Piping: 1/2" (15 mm) Fibreglass heavy density fibreglass insulation with factory applied all service vapour barrier jacket lapped and adhered with Flintkote 203 adhesive or equal. Seal all joints with 4" (100 mm) wide strip of all service jacket material.

.2 Base of roof hoppers insulated with moulded segments of a thickness equal to that of the pipe insulation finish with cement and wrapped with canvas.

.3 Alternative method for insulating fittings: Pre-moulded high impact PVC fitting covers with fibreglass inserts, end joints sealed with PVC tape.

.4 Exposed Insulation: Finish with PVC vapour barrier jacket and adhere with cement adhesive. Seal all joints with 4" (100 mm) wide strip of PVC tape.

.4 **Heating Supply and Return Piping (System Temperature of 141°F - 200°F (61°C - 94°C)):**

.1 Piping: Fibreglass heavy density fibreglass insulation with factory applied all service jacket lapped and adhered with Flintkote #203 adhesive or equal. Seal all joints with 4" (100 mm) wide strip of all service jacket material. Insulation conductivity shall be in the range of 0.25 - 0.29 BTU. in./(h.ft.^{3}°F) with mean temperature of 125°F.

.2 Fittings Valves and Flanges: Moulded or fabricated segments of a thickness equal to that of the pipe insulation and finished with a layer of asbestos free finishing cement, trowelled smooth and covered with canvas.

.3 Alternative method for insulating fittings: Pre-moulded high impact PVC fitting covers with fibreglass inserts, end joints sealed with PVC tape.

.4 Exposed Insulation: Finish with PVC vapour barrier jacket and adhere with cement adhesive. Seal all joints with 4" (100 mm) wide strip of PVC tape.

.5 Insulation shall be of thicknesses as follows:

Pipe Size	Insulation Thickness
1/2" (15 mm) - 1-1/4" (32 mm) ∅ pipe	1-1/2" (40 mm)
1-1/2" (40 mm) - 8" (200 mm) ∅ pipe	2" (50 mm)

.6 Unions and piping between shutoff valve and coil not exceeding 4'-0" (1200 mm) do not have to be insulated.

.5 **Piping Exposed to Outdoor Conditions:**

.1 Piping - Fibreglass heavy density fibreglass insulation with factory applied all service vapour barrier jacket lapped and adhered with adhesive. Insulation conductivity shall be in the range of 0.22 - 0.28 BTU in/(h.ft.^{3}°F) with mean temperature of 100°F (38°C). Seal all joints with 4" (100 mm) wide strip of all service jacket material. Finished with a smooth layer of asbestos free finishing cement and covered with canvas.

.2 Fittings Valves and Flanges: Moulded or fabricated segments of a thickness equal to that of the pipe insulation and finished with a layer of asbestos free finishing cement, trowelled smooth.

.3 Apply over insulation a high performance jacketting complete with cold weather acrylic adhesive, zero permeability, vapour barrier, UV resistant, mold resistant, tear resistant, high puncture resistant. Flame spread rating to be 10 and smoke rating to be 20.

.1 Base Bid: VentureClad Model 1577CW-natural aluminum

.2 Alternate Products:

.1 Polyguard Products Inc.

.2 Flex Clad

.3 Venture Tape

.4 Jackets on fittings 0.016" (0.045 mm) (26 gauge) thick die-shaped components of alloy aluminum laps with factory applied protective liner on interior surfaces.

.5 Insulation shall be of thicknesses as follows:

Pipe Size	Insulation Thickness
1/2" (15 mm) - 1 1/4" (32 mm) ∅ pipe	1-1/2" (40 mm)
1-1/2" (40 mm) - 8" (200 mm) ∅ pipe	2" (50 mm)

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verify existing conditions before starting work.

.2 Verify that piping has been tested before applying insulation materials.

.3 Verify that surfaces are clean, foreign material removed, and dry.

3.2 **INSTALLATION**

.1 Install materials to manufacturer's written instructions.

.2 On exposed piping, locate insulation and cover seams in least visible locations.

.3 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

.1 Provide vapour barrier jackets, factory applied or field applied.

.2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.

.3 Finish with glass cloth and vapour barrier adhesive.

.4 PVC fitting covers may be used.

.5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

.6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies and expansion joints.

.4 For insulated pipes conveying fluids above ambient temperature:

.1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.

.2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

.3 Finish with glass cloth and adhesive.

.4 PVC fitting covers may be used.

.5 For hot piping conveying fluids 60 degrees C (140 degrees F) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

.6 For hot piping conveying fluids over 60 degrees C (140 degrees F), insulate flanges and unions at equipment.

.5 **Inserts and Shields:**

.1 Application: Piping 40 mm (1-1/2 inch) diameter or larger.

.2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

.3 Insert Location: Between support shield and piping and under the finish jacket.

.4 Insert Configuration: Minimum 150 mm (6 inches) long, of same thickness and contour as adjoining insulation; may be factory fabricated.

.5 Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

.6 Finish insulation at supports, protrusions, and interruptions.

.7 For pipe exposed in mechanical equipment rooms or in finished spaces below 3 m (10 ft.) above finished floor, finish with canvas jacket sized for finish painting, PVC jacket and fitting covers, ABS jacket and fitting covers, aluminum jacket, stainless steel jacket as appropriate.

.8 For exterior applications, provide vapour barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement. Cover with [aluminum] [stainless steel] jacket with seams located on bottom side of horizontal piping.

.9 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with 0.025 mm (1.0 mil) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

.10 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum or stainless steel jacket with seams located on bottom side of horizontal piping.

3.3 TOLERANCE

.1 Substituted insulation materials: Thermal resistance within 10% at normal conditions, as materials indicated.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Pipe and pipe fittings for:

- .1 Heating water piping system.
- .2 Equipment drains and overflows.

.2 Valves:

- .1 Gate valves.
- .2 Globe or angle valves.
- .3 Ball valves.
- .4 Plug valves.
- .5 Butterfly valves.
- .6 Check valves.

1.2 RELATED SECTIONS

.1 Section 09 91 22 - Painting.

.2 Section 23 05 16 - Piping Expansion Compensation.

.3 Section 23 05 53 - Mechanical Identification.

.4 Section 23 05 48 - Vibration Isolation.

.5 Section 23 07 19 - Piping Insulation.

.6 Section 23 21 16 - Hydronic Specialties.

.7 Section 23 25 00 - Chemical Treatment for Piping.

.8 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASME Boiler and Pressure Vessel Code (BPVC), Section IX-2105 - Welding and Brazing Qualifications.

.4 ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.

.5 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

.6 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.7 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.

.8 ASME B31.9 - Building Services Piping.

.9 ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

.10 ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

.11 ASTM B32 - Standard Specification for Solder Metal.

.12 ASTM B88M - Standard Specification for Seamless Copper Water Tube.

.13 ASTM B88 - Standard Specification for Seamless Copper Water Tube.

.14 ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

.15 ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

.16 ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

.17 ASTM D2310 - Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

.18 ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

.19 ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

.20 ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.

.21 ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

.22 ASTM D2751 - Standard Specification for Acrylonitrile Butadiene Styrene (ABS) Sewer Pipe and Fittings.

.23 ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

.24 ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

.25 ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.

.26 ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot and Cold Water Distribution Systems.

.27 AWS A5.8/A5.8M-AMD 1 - Specification for Filler Metals for Brazing and Braze Welding.

.28 AWS D1.1/D1.1M - Structural Welding Code - Steel.

.29 AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

.30 AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings for Water.

.31 AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.32 AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.

.33 MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.4 **SYSTEM DESCRIPTION**

.1 Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

.2 Use grooved mechanical couplings and fasteners in accessible locations.

.3 Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

.4 Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

.5 Provide pipe hangers and supports to ASME B31.9 unless indicated otherwise.

.6 Use isolating valves for shut-off and to isolate equipment, part of systems, or vertical risers.

.7 Use ball valves for throttling, bypass, or manual flow control services.

.8 Use spring loaded check valves on discharge of condenser water pumps.

.9 Use plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

.10 Use lug end butterfly valves to isolate equipment.

.11 Use 20 mm (3/4 inch), ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

1.5 **SUBMITTALS FOR REVIEW**

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.6 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Welders Certificate: Include welders' certification of compliance with ASME BPVC-Section IX or AWS D1.1/D1.1M, as applicable to the application.

.3 Installation Data: Manufacturer's special installation requirements including hanging and support methods, joining procedures.

1.7 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

.3 Record Documentation: Record actual locations of valves.

1.8 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials: Provide two (2) repacking kits for each size and valve type.

1.9 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

.3 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience.

.4 Welders: Certify to ASME BPVC-Section IX or AWS D1.1/D1.1M.

.5 All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

.6 All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.10 **REGULATORY REQUIREMENTS**

.1 Conform to ASME B31.9 code for installation of piping system.

.2 Welding Materials and Procedures: Conform to [ASME BPVC-Section IX] [applicable provincial labour regulations].

.3 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.11 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept valves on site in shipping containers with labeling in place. Inspect for damage.

.3 Provide temporary protective coating on cast iron and steel valves.

.4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

.5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.12 **SITE CONDITIONS**

.1 Ambient Conditions: Do not install underground piping when bedding is wet or frozen.

Part 2 - Products

2.1 **HEATING WATER PIPING, ABOVE GROUND**

.1 **Steel Pipe:** ASTM A53/A53M, Schedule 40, 10 mm (3/8 inch) for wall for sizes 300 mm (12 inches) and over, black.

.1 Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type fittings.

.2 Joints: Threaded, or AWS D1.1/D1.1M, welded.

.2 **Copper Tubing:** ASTM B88M (ASTM B88).

.1 Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.

.2 Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

.3 Joints:

.1 Solder, lead free, ASTM B32 tin-antimony, or tin and silver, with melting range 220-280 degrees C (430-535 degrees F).

.3 **Grooved Mechanical Joints:**

.1 1-1/2" (40 mm) pipe and larger to be standard steel pipe. Light wall pipe is not acceptable.

.2 The grooves and gaskets must be installed according to Manufacturer's installation instructions. The groove must be clean and true. The gasket seat pipe surface must be free of indentations, roll marks and projections.

.3 The gaskets shall be standard Grade EHP -30°F (-34°C) to 250°F (120°C) or Grade E -30°F (-34°C) to 230°F (110°C) and 300 psig (2065 kPa). Gaskets shall be suitable for use with 40% ethylene glycol or of a grade suitable for the intended service.

.4 The couplings shall consist of two ductile iron housing segments and be a combination of rigid joints in risers, Mechanical Rooms, and where flexibility is not desired; and flexible couplings for controlled pipe movement and flex-connector elimination.

.1 Rigid Type: Housings shall be cast with torque absorber and shift limiting offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9, and to prevent mis-assembly due to overshift. Housings cast with alignment indicator notch for visual proper alignment to adjoining fitting. Installation-Ready, for direct stab installation without field disassembly, with Grade EHP gasket rated to +250 deg F / 120 deg C. Victaulic Style 107V.

.1 Flexible Type: Victaulic Installation-Ready Style 177N or Style 77 and Style 75.

.2 14" (350 mm) through 24" (600 mm): Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.

.1 Rigid Type: Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07.

.2 Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement. Victaulic Style W77.

.2 Valves and Fittings - Grooved end fittings, grooved end valves, and specialties may be used as part of the mechanical joint system.

.1 Fittings shall be cast of ductile iron to ASTM A536, wrought steel to ASTM A234, or factory fabricated from steel pipe to ASTM A53.

.2 QuickVic 2” through 12” (50 mm through 300 mm); ASTM A536 Grade 65-45-12 ductile iron with Victaulic Original Grooved System (OGS) grooved ends, stiffening ribs, and alignment indicators, orange coated or hot dipped galvanized as per ASTM A123, working pressure 400-psi (2758-kPa). Victaulic QuickVic™ V10 (90-deg), V11 (45-deg), and V20 (tee).

.5 All elbows are to be long radius type.

.6 Copper pipe fittings to be cast copper alloy solder joint pressure fittings to ANSI B16.18-2001 or wrought copper and copper alloy solder joint pressure fittings to ANSI/ASME B16.22-2001.

.7 Design based on Victaulic

.8 Acceptable Products:

.1 Victaulic

.2 Shurjoint

.3 Grinnell

2.2 **EQUIPMENT DRAINS & OVERFLOWS**

.1 **Steel Pipe:** ASTM A53/A53M, Schedule 40 galvanized.

.1 Fittings: Galvanized cast iron, or ASME B16.3, malleable iron.

.2 Joints: Threaded, or grooved mechanical couplings.

.2 **Copper Tubing:** ASTM B88M (ASTM B88), Type H (drawn).

.1 Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.

.2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220 to 280 degrees C (430 to 535 degrees F).

2.3 **PIPE HANGERS & SUPPORTS**

.1 Conform to ASME B31.9, ASTM F708, MSS SP-58].

.2 Hangers for Pipe Sizes 13 to 38 mm (1/2 to 1-1/2 inch): Malleable iron or Carbon steel, adjustable swivel, split ring.

.3 Hangers for Hot Pipe Sizes 50 to 100 mm (2 to 4 inches): Carbon steel, adjustable, clevis.

.4 Hangers for Hot Pipe Sizes 150 mm (6 inches) and Over: Adjustable steel yoke, cast iron roll, double hanger.

.5 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.6 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm (6 inches) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

.7 Wall Support for Pipe Sizes to 76 mm (3 inches): Cast iron hook.

.8 Wall Support for Pipe Sizes 100 mm (4 inches) and Over: Welded steel bracket and wrought steel clamp.

.9 Wall Support for Hot Pipe Sizes 150 mm (6 inches) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

.10 Vertical Support: Steel riser clamp.

.11 Floor Support for Hot Pipe Sizes to 100 mm (4 inches): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.12 Floor Support for Hot Pipe Sizes 150 mm (6 inches) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

.13 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.14 Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

.15 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 **UNIONS, FLANGES, & COUPLINGS**

.1 Unions for Pipe 50 mm (2 inches) and Under:

.1 Ferrous Piping: 1034 kPa (150 psig) malleable iron, threaded.

.2 Copper Pipe: Bronze, soldered joints.

.2 Flanges for Pipe Over 50 mm (2 inches):

.1 Ferrous Piping: 1034 kPa (150 psig) forged steel, slip-on.

.2 Copper Piping: Bronze.

.3 Gaskets: 1.6 mm (1/16 inch) thick preformed neoprene.

.3 **Grooved and Shouldered Pipe End Couplings:**

.1 Housing Clamps: Malleable iron galvanized to engage and lock, designed to permit some angular deflection, contraction, and expansion.

.2 Sealing Gasket: C-shape elastomer composition for operating temperature range from -34 degrees C (-30 degrees F) to 110 degrees C (230 degrees F).

.3 Accessories: Steel bolts, nuts, and washers.

.4 **Dielectric Connections:** Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.5 **GATE VALVES**

.1 Up To and Including 50 mm (2 inches):

.1 Manufacturers:

.1 Crane

.2 Grinnell

.3 Newman-Hattersley

.4 Milwaukee

.5 Kitz

.2 Bronze body, bronze trim, screwed bonnet, rising stem, lockshield stem, inside screw with backseating stem, solid wedge disc, alloy seat rings, threaded ends.

.2 Over 50 mm (2 inches):

.1 Manufacturers:

.1 Crane

.2 Grinnell

.3 Newman-Hattersley

.4 Milwaukee

.5 Kitz

.2 Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged or grooved ends.

2.6 **GLOBE OR ANGLE VALVES**

.1 Up To and Including 50 mm (2 inches):

.1 Manufacturers:

.1 Crane

.2 Grinnell

.3 Newman-Hattersley

.4 Milwaukee

.5 Kitz

.2 Bronze body, bronze trim, bonnet, rising stem and handwheel, inside screw [with backseating stem], [renewable composition disc and bronze seat], renewable plug disc and stainless steel seat ring, threaded ends.

.2 Over 50 mm (2 inches):

.1 Manufacturers:

.1 Crane
.2 Grinnell
.3 Newman-Hattersley
.4 Milwaukee
.5 Kitz

.2 Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.

2.7 **BALL VALVES**

.1 Up To and Including 50 mm (2 inches):

.1 Manufacturers:

.1 Crane
.2 Grinnell
.3 Newman-Hattersley
.4 Milwaukee
.5 Kitz

.2 Bronze Stainless steel, one (1) body, stainless steel ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder or threaded ends with union.

.2 Over 50 mm (2 inches):

.1 Manufacturers:

.1 Crane
.2 Grinnell
.3 Newman-Hattersley
.4 Milwaukee
.5 Kitz

.2 Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, or gear drive handwheel for sizes 250 mm (10) and over, flanged.

2.8 **PLUG VALVES**

.1 Up To and Including 50 mm (2 inches):

.1 Manufacturers:

.1 Crane
.2 Grinnell
.3 Newman-Hattersley
.4 Milwaukee
.5 Kitz

.2 Bronze body, bronze tapered plug, full port opening, non-lubricated, teflon packing, threaded ends.

.3 Operator: One plug valve wrench for every ten plug valves minimum of one.

.2 Over 50 mm (2 inches):

.1 Manufacturers:

.1 Crane
.2 Grinnell
.3 Newman-Hattersley
.4 Milwaukee
.5 Kitz

.2 Cast iron body and plug, full port opening, pressure lubricated, teflon packing, flanged ends.

.3 Operator: Each plug valve with a wrench with set screw.

2.9 **BUTTERFLY VALVES**

.1 Up to 2" (50 mm):

.1 Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.

.2 Disc: Stainless steel

.3 Operator: Infinite position lever handle with memory stop.

.4 Manufacturers:

.1 Crane
.2 Grinnell
.3 Newman-Hattersley
.4 Milwaukee
.5 Kitz

.2 2" to 24" (50 mm to 600 mm) grooved ends, ductile iron body, stainless steel stem with elastomer seat, pressure respo0nsive in sizes through 12”, disc mounted for 14” and larger. (Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.)

.1 Victaulic Vic300 MasterSeal and AGS Vic300.

2.10 **SWING CHECK VALVES**

.1 Up To and Including 50 mm (2 inches):

.1 Manufacturers:

.1 Crane
.2 Grinnell
.3 Newman-Hattersley
.4 Milwaukee
.5 Kitz

.2 Bronze body, bronze trim, bronze rotating swing disc, with composition disc, threaded ends.

.2 Over 50 mm (2 inches):

.1 Manufacturers:

.1 Crane
.2 Grinnell
.3 Newman-Hattersley
.4 Milwaukee

.5 Kitz

.2 Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

2.11 **SPRING LOADED CHECK VALVES**

.1 Manufacturers:

.1 Crane
.2 Grinnell
.3 Newman-Hattersley
.4 Milwaukee
.5 Kitz

.2 Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

.3 2" to 24" (50 mm to 600 mm): Grooved end ductile iron body, with stainless steel spring, suitable for vertical installation.

.1 Stainless steel disc with elastomer seat / seal.
.2 Elastomer coated ductile iron disc with welded-in nickel seat.
.3 Victaulic Series 716 and AGS W715.

Part 3 - Execution

3.1 **PREPARATION**

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

.2 Remove scale and dirt on inside and outside before assembly.

.3 Prepare piping connections to equipment with flanges or unions.

.4 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

.5 After completion, fill, clean, and treat systems. Refer to Section 23 25 00.

3.2 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Install heating water, glycol, chilled water condenser water, and engine exhaust piping to ASME B31.9. Install chilled water piping to ASME B31.5.

.3 Route piping in orderly manner, parallel to building structure, and maintain gradient.

.4 Install piping to conserve building space, and not interfere with use of space.

.5 Group piping whenever practical at common elevations.

.6 Sleeve pipe passing through partitions, walls and floors.

.7 Slope piping and arrange to drain at low points.

.8 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

.9 **Inserts:**

.1 Provide inserts for placement in concrete formwork.

.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm (4 inches).

.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.

.10 **Pipe Hangers and Supports:**

.1 Install to ASTM F708 ASME B31.9.

.2 Support horizontal piping as scheduled.

.3 Install hangers to provide minimum 13 mm (1/2 inch) space between finished covering and adjacent work.

.4 Place hangers within 300 mm (12 inches) of each horizontal elbow.

.5 Use hangers with 38 mm (1-1/2 inch) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

.6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Provide copper plated hangers and supports for copper piping sheet lead packing between hanger or support and piping.

.9 Prime coat exposed steel hangers and supports. Refer to Section 09 91 22. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

.11 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.

.12 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.

.13 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

.14 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

.15 Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 91 22.

.16 Install valves with stems upright or horizontal, not inverted.

3.3 SCHEDULES

.1 **Hanger Rod:**

Pipe Size	Max. Hanger Spacing	Diameter
12-32 mm (1/2-1-1/4 inch)	2000 mm (6.5 ft)	9 mm (3/8 inch)
38-50 mm (1-1/2-2 inch)	3000 mm (10 ft)	9 mm (3/8 inch)
62-75 mm (2-1/2-3 inch)	3000 mm (10 ft)	13 mm (1/2 inch)
100-150 mm (4-6 inch)	3000 mm (10 ft)	15 mm (5/8 inch)
200-300 mm (8-12 inch)	4250 mm (14 ft)	22 mm (7/8 inch)

Pipe Size	Max. Hanger Spacing	Diameter
350 mm and over (14 inch and over)	6000 (20 ft)	25 mm (1 inch)
PVC (All Sizes)	1800 mm (6 ft)	9 mm (3/8 inch)

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Expansion tanks.

.2 Air vents.

.3 Air separators.

.4 Strainers.

.5 Pump suction fittings.

.6 Combination fittings.

.7 Flow indicators, controls, meters.

.8 Radiator valves.

.9 Relief valves.

.10 Radiant Floor Heating System

1.2 RELATED SECTIONS

.1 Section 22 42 01 - Plumbing Specialties: Backflow Preventers.

.2 Section 23 21 00 - Hydronic Piping.

.3 Section 23 25 00 - Chemical Treatment for Piping: Pipe Cleaning.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASME Boiler and Pressure Vessels Code (BPVC), Section VIII-1-2105 - Rules for Construction of Pressure Vessels.

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Certificates: Submit inspection certificates for pressure vessels from authority having jurisdiction.

.3 Installation Data: Indicate hanging and support methods, joining procedures.

1.6 CLOSEOUT SUBMITTALS

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Maintenance Contracts:

.1 Provide service and maintenance of glycol system for one (1) year from date of substantial completion.

.2 Monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

.3 Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

.4 Record Documentation: Record actual locations of flow controls flow meters.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials: Provide one (1) extra [4 L (1 gal)] [40 L (10 gal)] [205 L (55 gal)] drum of [propylene] [ethylene] glycol.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.9 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept valves on site in shipping containers with labeling in place. Inspect for damage.

.3 Provide temporary protective coating on cast iron and steel valves.

.4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

.5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

Part 2 - Products

2.1 **DIAPHRAGM-TYPE EXPANSION TANKS**

.1 Manufacturers:

.1 Amtrol

.2 Sarco

.3 Hamlet & Garneau

.4 Letrol

.2 **Construction:** Welded steel, tested and stamped to ASME BPVC-Section VIII-1; supplied with National Board Form U-1, rated for working pressure of 860 kPa (125 psig), with flexible butyl diaphragm sealed into tank and steel support stand.

.3 **Accessories:** Pressure gauge and air-charging fitting, tank drain; precharge to 80 kPa (12 psig).

.4 **Automatic Cold Water Fill Assembly:** Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

.5 Size - refer to schedule.

2.2 **AIR VENTS**

.1 Manual Type: Short vertical sections of 50 mm (2 inch) diameter pipe to form air chamber, with 3 mm (1/8 inch) brass needle valve at top of chamber.

.2 **Float Type:**

.1 Manufacturers:

.1 Armstrong
.2 Braukmann
.3 Amtrol
.4 ITT

.2 Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

.3 Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.3 **AIR SEPARATORS**

.1 **Combination Air Separators/Strainers:**

.1 Manufacturers:

.1 Armstrong
.2 Braukmann
.3 Amtrol
.4 ITT

.2 Steel, tested and stamped to ASME BPVC-Section VIII-1; for 860 kPa (125 psig) operating pressure, with integral bronze galvanized steel strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.4 **STRAINERS**

.1 **Strainers:** Size 50 mm (2 inch) and Under:

.1 Manufacturers:

.1 Colton
.2 Sarco
.3 Armstrong
.4 Mueller
.5 Watts

.2 Screwed brass or iron body for 1200 kPa (175 psig) working pressure, Y pattern with 0.8 mm (1/32 inch) stainless steel perforated screen.

2.5 **PUMP SUCTION FITTINGS**

.1 Manufacturers:

.1 ITT
.2 Taco
.3 S.A. Armstrong

.2 **Fitting:** Angle pattern, cast-iron body, threaded for 50 mm (2 inch) and smaller, flanged for 65 mm (2-1/2 inch) and larger, rated for 1200 kPa (175 psig) working pressure, with inlet vanes, cylinder strainer with 5 mm (3/16 inch) diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

.3 **Accessories:** Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.6 COMBINATION PUMP DISCHARGE VALVES

.1 Manufacturers:

.1 ITT

.2 Taco

.3 S.A. Armstrong

.2 **Valves:** Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 1200 kPa (175 psig) operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.7 CIRCUIT BALANCING VALVES

.1 Manufacturers:

.1 S. A. Armstrong

.2 Tour & Anderson

.3 Watts

.4 Newman-Hattersley

.2 **Construction:** Brass or bronze body with union on [inlet] [outlet], temperature and pressure test plug on [inlet] [outlet] [inlet and outlet] [blowdown/backflush drain].

.3 **Calibration:** Control flow within 5% of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 24 kPa (3.5 psig).

.4 **Control Mechanism:** Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.

.5 **Accessories:** In-line strainer on inlet and ball valve on outlet.

2.8 RADIATOR VALVES

.1 Manufacturers:

.1 Crane

.2 Watts

.3 Dahl

.2 Angle or straight pattern, rising stem, inside screw globe valve for 860 kPa (125 psig) working pressure, with bronze body and integral union for screwed connections, renewable composition disc, plastic wheel handle for shut-off service, and lockshield key cap and set screw memory bonnet for balancing service.

2.9 RELIEF VALVES

.1 Manufacturers:

.1 Watts

.2 S. A. Armstrong

.3 Bell & Gossett

.2 Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME BPVC certified and labelled.

2.10 **RADIANT FLOOR HEATING SYSTEM - DESIGNATED RIH-1, RIH-2**

.1 **General**

.1 Furnish and install a Klimatrol Environmental System's Radiant Floor Heating (RFH) system as manufactured by REHAU. System shall be complete with Raupex ® piping and Everloc ® cold-expansion fittings.

.2 The Cross-linked polyethylene (PEXa) pipe shall be high-pressure peroxide method with a minimum 80-85% cross-linking conforming to ASTM F 876, F 877 and CSA B 137.5. and DIN 4726 oxygen diffusion. Fittings shall conform to ASTM F 877, F 2080 and CSA B 137.5.

.3 Additional components shall consist of 'ANURAV Pre-Assembly' complete with 5/8" Raupex, Heat Exchangers, actuators, mixing valves, circuit actuators, local pumps, manifolds, BACnet Controllers, R-20's, sensors, and manifolds. Installation accessories of Non-metallic pipe fasteners, tube protection sleeving, special tools and pressure test kits.

.2 **Submittals:**

.1 Provide submittals and Shop Drawings in accordance with the General Requirements and as specified herein. Shop Drawings shall indicate schematic layout of system, including equipment, critical dimensions and piping/slab penetration.

.2 Submit manufacturer's technical installation instructions.

.3 Submit independent certification results for the piping systems from a recognized testing laboratory.

.4 Submit system design indicating pipe sizing, floor construction, floor covering, tubing layout and output capacity at pipe spacing and water temperatures selected. Design calculations to be performed on pipe manufacturer's software using ASHRAE heat loss data on the basis of continuous 24 h /day, 7 day per week heating cooling operation.

.5 Submit catalog data on all equipment, fittings, fasteners and associated items necessary for the installation of the piping and manifolds.

.6 Submit installer's certification and project installation resume of experience. System shall be installed by a contractor experienced in radiant floor cooling / heating system installation.

.3 **Warranty**

.1 The radiant floor heating pipe manufacturer shall warrant the cross-linked polyethylene piping and any "Everloc" fittings, to be free from defects in material and workmanship for a period of twenty-five (25) years. The design shall be approved either by submittal or stamped by a registered engineer as being complete and accurate.

.2 All manifolds and controls shall be warranted for 18 months and/or two heating seasons.

.3 Coordinate services of Klimatrol Environmental Systems Ltd to provide Letters of Inspection of installation and witnessing pressure test prior to the thermal mass emplacement. Klimatrol shall provide Owner Training on proper operation and maintenance of the system and provide Owner with "As-built" shop drawings, manuals and certified Installation Warranty.

.4 **Piping:**

.1 All radiant floor heating piping shall be nominal high density cross-linked polyethylene as manufactured by REHAU using the peroxide method of cross-linking (PEXa) and with an approved cell classification in accordance with ASTM D 3350. Pipe shall conform with ASTM F 876 and CSA B 137.5, and be certified by CSA.

.2 Temperature and Pressure Ratings: Piping shall be rated for 100 PSIG gauge pressure at 180 Deg.F temperature (690 kPa @ 82°C) continuous, and 80 PSIG gauge pressure at 200 Deg.F temperature (550 kPa @ 93°C) continuous.

.3 Oxygen Diffusion Barrier: Piping shall have a co-extruded oxygen diffusion barrier capable of limiting oxygen diffusion through the pipe to less than 0.10 mg/l/day at 104 deg. F (40°C) water temperature, in accordance with DIN 4726.

.4 The minimum bend radius for cold bending of the pipe shall be not less than five (5) times the outside diameter. Bends with a radius less than this shall require the use of a bending template as supplied by the pipe manufacturer, and/or hot air.

.5 Install Radiant heating cooling piping in pattern as shown on Klimatrol shop drawings. Counter flow spiral layout shall be required on slab cooling applications and spiral pattern for general heating applications.

.5 **Fittings:**

.1 Fittings shall be manufactured of dezincification-resistant brass and shall be supplied by the piping manufacturer as a proven part of cataloged system. Manifold fittings shall be compression nut style with split compression ring.

.2 Fittings shall be certified to ASTM F 877, F 2080 and CSA B 137.5 as part of the manufacturer's PEX piping system. Pipe couplings embedded within the thermal mass or behind drywall shall be EVERLOC® cold-expansion compression-sleeve fittings.

.6 **Manifolds:**

.1 Distribution manifolds shall be manufactured of dezincified brass or stainless steel and be a proven cataloged part of the manufacturer's system.

.2 Rehau Pro-Balancing Manifolds shall be equipped with visual circuit flow gauges, balancing valves and isolation valves for each circuit. Manifold isolation valves, air vent, and drain service ports shall be pre-assembled and mounted on metal brackets ready to install.

.3 Each manifold shall be provided with automatic air vent. Manifolds shall be incorporated into Pre-Build KLIMAPANEL.

.7 **KLIMAPANEL and Controls:**

.1 KLIMAPANEL pre-built pump / mixing panel shall maintain space and floor temperature setpoints. The panels shall consist of 0-10V DC mixing valve and slow opening 24V Zone control valves, space for BAS controller including temperature mixing and slab safety features.

.2 Supply, Return and Floor Slab sensors shall be a 10 k Ω NTC Type II thermistor. BAS shall sense space temperature and floor slab temperature with target air temperature of (72F), floor slab not to exceed 91F (33C) at design heating output and (95F) maximum slab temperatures. Maximum supply water temperature limit of 140F and shall not be exceeded. System shall de-energize if maximum temp is exceeded by 2F or more for a period greater than 10 minutes. If no call for heat is received Manifold zone valves and circulators shall operate for a minimum of 10 minutes then shutdown. Radiant floor heating system shall be enabled on outdoor temperature below 68 deg. if registered for a period greater than one hour. Provide and install spare slab sensors.

.3 Supply sensors shall be mounted on manifolds and KLIMAPANEL controller shall prioritize modulating supply fluid temperature to maintain target supply temperature. Space temperatures in individual zones shall be provided indirectly back to KLIMAPANEL via BAS. BAS Shall provide space sensors.

.4 Water cooled fractional horsepower 120V/1Ph, FLA: 3 Amp Pumps shall be silent and energy efficient as manufactured by Grundfos and sized specifically for area being heated.

.5 KLIMAPANEL shall be complete with BACnet ready controls

.8 **Accessories:** Required installation accessories shall include: nylon cable binders or Railfix tube track, pipe conduit bend guides, protective sleeving, pressure test kit, pipe cutter, pipe uncoiler, Everloc tool kit and other installation tools and aids required for complete installed and approved system.

.9 **Preparation:**

.1 Concrete Slab on Grade: Subgrade should be compacted, flat and smooth to prevent damage to pipe or insulation. Approved vapor barrier material should be installed. Insulation shall be installed vertically along all exterior walls or footings to which the edge of the slab will meet against. Horizontal insulation shall be installed flat against the vapor barrier under which the slab will be poured. Reinforcing wire mesh or rebar, if required by structural design, must be flat and level, with all sharp ends pointing down. Finished grade of the thermal mass shall be minimum of 3/4" (19 mm) above the top of PEX heating pipes.

.2 Install floor heating piping in a combination spiral / counter flow spiral design pattern as shown on the Klimatrol piping design shop drawings.

.3 All floor heating piping shall be fastened using nylon cable binders to a middle rebar mesh (provided by general contractor) maintaining a consistent level and minimum 50 mm pipe clearance from top or bottom of the concrete slab. Preferred level is just above midpoint of the concrete slab. Coordinate mesh elevation in slab for low level in radiant ceilings or high level in radiant floors.

.4 Pre-cast Concrete Subfloor: Subfloor must be clean and free from all construction debris and sharp edges. Replace any areas that appear weak. If called for by design, approved vapor barrier and insulation shall be installed vertically along all exterior walls slab edges as well as flat under where the slab will be poured. Finished grade of the thermal mass overpour must be a minimum of 3/4" (19 mm) above the top of PEX heating pipes.

.5 Manifold Installation and Preparation of Wall Cavity: Review drawings and/or design to determine proper locations for manifolds. Check cabinet specifications to determine the size of the wall opening dimensions. Typical cabinets are 24" H x 30", 36" 42" or 48" Wide and 7" Deep. Mount the manifold cabinet minimum 4" (100 mm) above finished surface. If a cabinet is not used, prepare a suitable cavity for the manifold providing a secure mounting plate that will place the manifold at least 28 inches (72 cm) above floor level. If a manifold is to be installed on a wall that will not be constructed until after the heating pipe installation, then a temporary support must be built to secure the manifold in the location that it will stay in after the wall is constructed. Manifold must be installed in an area that will allow easy access for supply/return piping as well as future access for maintenance.

.10 **Installation:**

.1 Install in accordance with manufacturer's published installation manual and/or published guidelines.

.2 Mount manifolds in the locations previously prepared or in previously installed cabinets, if used. Manifolds should be mounted level and wrapped in plastic to be protected during construction from dirt, dust or concrete during pour.

.3 Route piping in neat and professional manner, according to layout and spacing shown in approved submittal drawings. All notes on drawings shall be followed.

.4 Avoid installing tubing under built-ins or within 6" (150 mm) of walls, floor plates or any floor penetrations. Mark locations of in-slab piping on concrete surfaces so other trades avoid slab drilling, coring, anchoring or penetrations

.5 For crack control ensure thermal slab is segmented into smaller sections by movement joints or saw cut, avoid crossing movement joints. Any Saw cuts shall not exceed 3/4" (19 mm) depth and not score installed pipe.

.6 Provide Slab sensor conduit sleeve from manifold to zone locations. See shop drawing and mechanical drawings for thermal zoning layout. Use separate loops for different rooms allowing for better temperature control. Maximum under floor covering subsurface temperature shall not exceed 100F (38C). Thinner denser floor coverings preferred for better heat transfer, do not exceed Maximum Surface temperatures of 85F in occupied areas, 90F in high traffic and washroom areas and 95F in perimeter areas.

.7 At connections and fittings, use a Rehau plastic pipe cutter to ensure square and clean cuts, join pipes immediately or cap ends of pipe to seal from contaminants. Where fittings are installed within the thermal mass, they shall be wrapped in chloride-free tape or sealed within a heat-shrink material approved by the manufacturer.

.8 Pipe should be dispensed using an uncoiling device. Remove all twists prior to securing pipe. Pipe must lie flat on an even plane. Install tubing at a consistent depth below surface. Finished grade of a thermal mass must be a minimum of 3/4" (19 mm) above the top of PEX heating pipes. Fasten piping at no more than 3 feet (90 cm) intervals, being careful not to twist the pipe. In thin concrete slabs, it may be necessary to secure piping every 2 feet (60 cm). Use only fasteners supplied or approved by the manufacturer of the PEX pipe.

.9 Piping that must pass through expansion joints shall be covered in protective polyethylene convoluted sleeving (flexible conduit) extending 8 inches (20 cm) on each side of the joint. Sleeving must be secured on pipe to prevent movement during installation of thermal mass.

.10 Where piping exits the thermal mass, a protective conduit shall be placed around the pipe, with the conduit extending a minimum of 6 inches (15 cm) into the floor and exiting by a minimum of 6 inches. For penetrations at manifolds, use rigid PVC bend guides secured in place to prevent movement.

.11 At the time of installation of each circuit of pipe, connect the pipe to the correct manifold outlet and record pipe length for balancing. If manifold is not installed, cap the end of the pipe and label the pipe's circuit numbers along with S for supply and R for return. Connect pipes to manifold as soon as possible and record circuit lengths. Label all circuits to indicate circuit length and zone area.

.12 The heating system should not be put into operation until the poured concrete thermal mass has cured a minimum of 28 days, unless otherwise specified and approved by thermal mass supplier. If it is necessary to operate the heating system to prevent freezing, a maximum flow temperature of 72 deg. F (22°C) must not be exceeded while the thermal mass is curing. After curing, gradually increase the flow temperature by no more than 10 deg. F (6°C) each day until system reaches the required operating temperature.

.13 General Contractor shall be responsible for provision of minimum 2" (50 mm) thick 60 PSIG compressive strength rigid insulation. General Contractor shall also provide wire mesh or rebar to secure tubing. Coordinate with Architectural and Structural details and plans. Insulation thickness can decrease to 1/2" (R2.5) if system installed over a heated space.

.14 Mechanical Contractor shall be responsible for provision of

.1 Labour to install Radiant Floor Heating system

.2 Water and chemical solutions.

.3 Field coordination of the pressure test equipment.

.4 Supervision of concrete pours to instruct concrete installers on maintenance of pipe integrity and position of pipe in slab during concrete installation.

.5 Installation of control valves, pumps, supply and return piping, all valves and fittings.

.6 Electrical control interconnection and commissioning

.15 Field Quality Control - Request services of Klimatrol Environmental Systems to inspect and witness installation prior to emplacement of thermal mass.

.1 Manifold Filling, Testing & Balancing: Test the hydronic heating system in compliance with local codes, and, where required, shall be witnessed by the building official as well as Klimatrol Environmental Systems Ltd. (Reference BOCA, ICBO, SBCCI or the acceptable code body for the jurisdiction).

.2 Pressure gauges used must show pressure increments of 1 PSIG and should be located at or near the lowest points in the distribution system.

.3 Air Test: Charge the completed, yet unconcealed pipes with air. Do not exceed 120 PSIG. Use liquid gas detector or soap solution to check for leakage at manifold connections.

.1 Perform a preliminary pressure test pressurizing the system to the greater of 68 psi or 1.5 times the maximum operating pressure. As the piping expands, restore pressure, first at 10 minutes into the test and again at 20 minutes. At the end of the 30-minute preliminary test, pressure must not fall by more than 5 PSIG from the maximum, and there shall be no leakage.

.2 Perform the main pressure test immediately thereafter. The main pressure test shall not fall more than 3 PSIG after 2 hours and until system is placed into operation. No leakage should be detected.

.3 Pressure shall be maintained and monitored during installation of the thermal mass. If any leak is detected during installation of thermal mass, the leak must be found immediately and the area cleared for repair using manufacturer approved repair coupling. Retest before covering repair

.4 Water Test: Purge all air from pipes. Charge the completed, yet unconcealed pipes with water. Take necessary precautions to prevent water from freezing. Check the system for leaks, especially at all pipe joints.

.1 Perform the same procedures as used in the Air Test

.2 Request services of Klimatrol Environmental Systems to witness installation and pressure test prior to emplacement of thermal mass and to provide Letters of Inspection. Coordinate with Klimatrol for owner or owner's representative's training on

correct operation and maintenance of the system. Provide owner with "As-Built" shop drawings, manuals and Warranty document.

.11 **Sequence of Operation (Programmed by factory)**:

.1 Provide 120V Power to "on/off" switch inside the floor heat manifold panel

.2 Provide a slab sensor sleeved in conduit and positioned approximately halfway between two pipes and 3' - 6' feet from an outside wall

.3 Hydronic panel to be complete with a BAS controller, sensors and 24 V transformer within manifold cabinet. Controller shall sense supply fluid temperature, slab temperature and have provision to accept universal outdoor air temperature and room space temperature from BAS.

.4 Control shall provide: Target slab temperature of 74 deg. F (adjustable via BAS)

.5 When OAT is below 72 deg. F. Pump shall be energized and run continuously, 3-way valve shall modulate to maintain a supply water temperature based on an outdoor air temperature reset curve as follows:

OAT	72 deg. F	SWT	72 deg. F
OAT	14 deg. F	SWT	120 deg. F

.6 Control shall have a minimum supply fluid temperature setting of 85 deg. F.(adjustable)

.7 And a maximum supply fluid temperature of 140 deg. F.

.8 Control shall include slab temperature feedback for Proportional, Integral and Derivative function (PID) of supply fluid temperature. Utilize PID to modulate the 3- Way mixing valve to match supply water temperature as closely as possible to slab target temperature minimizing overshoot and undershoot.

.9 Above OAT of 72 deg. F control shall de-energize pump and 3-way valve shall close.

.10 If space temperature above 77 deg. F then floor heat shall be de energized-on space high limit cutout.

.11 On supply water temperature above 145 deg. F control shall provide for pump "high limit cutout" and remote alarm signal

.12 Three way valve shall limit slab temperature to a maximum 95 deg. F (adjustable)

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install specialties to manufacturer's written instructions.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipes.

.3 Provide manual air vents at system high points and as indicated.

.4 For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

.5 Provide air separator on suction side of system circulation pump and connect to expansion tank.

.6 Provide valved drain and hose connection on strainer blow down connection.

.7 Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

.8 Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.

.9 Support pump fittings with floor mounted pipe and flange supports.

.10 Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.

.11 Provide radiator balancing valves on water outlet from terminal heating units such as radiation, unit heaters, and fan coil units.

.12 Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

.13 Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

.14 Pipe relief valve outlet to nearest floor drain.

.15 Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

3.2 RADIANT FLOOR HEATING SYSTEM INSTALLATION

.1 Install piping in slab from manifolds without any joints. No loop length is to exceed the design parameters on the plans or as approved by the engineer. Tubing shall be marked every 3' for installation measurements. Maximum length shall be determined by design documents or tubing diameter.

.2 Secure piping in radiant floor slabs over 4" by attaching tubing to concrete steel rebar or webbing reinforcement using plastic tie straps. No metal wiring shall be used. Spacing shall be as shown on design plans or as approved by engineer within submittals. for floor sections of 4" or less, provide manufacturers plastic tracking strips for positive spacing and securing of tubing before pour.

.3 Where radiant heating tubing passes through an expansion joint within the radiant heating slab, install a sleeve tubing and extending for a minimum of 6 inches on each side of the slab penetration to prevent shearing.

.4 Install manifolds in accessible locations. Refer to plan view drawings. Install manifolds with all parts accessible for maintenance and replacement in the future as may be necessary.

.5 Slab construction components to be supplied by Mechanical Contractor:

- .1 Styrofoam Insulation, high density polystyrene of minimum R-10
- .2 Wire mesh
- .3 Rebar
- .4 Installation labour
- .5 Copper pipe, valves, fittings, drains
- .6 Waterproofing as required

3.3 RADIANT FLOOR HEATING SYSTEM COMMISSIONING

.1 Before any part of the tubing is covered for any reason, entire manifold and tubing system shall be pressure-tested as required by the manufacturer for warranty protection.

.2 Pressurize the entire radiant system with compressed air. Fit manifold connections with a suitable pressure gauge and charging connection. If manifold location is not permanent, properly support manifold on unistrut frame in the intended and designated permanent location. Charge system to a pressure of not less than 80 psig or more than 100 psig. Pressure test shall last for a minimum of 24 hours with not more than a 2 psig drop. With system air charged, soap test all joint on and within the manifolds.

.3 After hydrostatic test pressure has been applied, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.

.4 Site inspection reports must be prepared and provided by System Supplier for Warranty Validation.

.5 Any portion of tubing layout that rises as a result of being pressurized shall be re-secured to be at the proper level within the slab structure when poured.

.6 Prior to final system fill and commissioning the PEX tubing system and manifolds shall be flushed and cleaned. Supply all tools, connections, labor, and accessories necessary to properly remove all foreign material, chemical, and residue within the tubing system before permanently charging system and placing into operation.

.7 After system has been properly cleaned and flushed, fill system with clean water to proper cold fill pressure. Add water to the radiant system as required by using a positive displacement pump. Cold fill pressure should be between 15 psi and 30 psi.

.8 Purge each individual loop to eliminate air pockets in the system. After purging remove fill connection to any potable water lines to prevent any possibility of contamination.

.9 Operate radiant heating system with all balance valves in the fully open position. Balance system by return water temperature of each loop across manifold to be certain of even flow. Adjust individual loop balance valves as needed. After system balancing has been done, mark balancing valves to permanently indicate final balanced position.

.10 Final control commissioning and Owner Training shall be provided by System Vendor. System Vendor to coordinate with Mechanical Contractor and Commissioning Agent. Submit Commissioning Report to Consultant.

END OF SECTION

Part 1 - General

1.1 SUBMITTALS

.1 **Shop Drawings/Product Data**: Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe and fittings. Ensure that shop drawings/product data sheets confirm that products proposed meet all requirements of the Contract Documents.

.2 **Refrigerant Piping Schematics:** Submit, in shop drawing form, a schematic piping diagram for each refrigerant piping system indicating pipe sizes, slopes, valves, traps, and piping specialties Piping schematics must be reviewed, approved, and signed by the refrigeration equipment manufacturers prior to being submitted to the Consultant for review.

.3 **Certification Reports:** Submit letters from equipment suppliers certifying proper installation and start-up of the piping systems and equipment as specified in Part 3 of this Section.

1.2 QUALITY ASSURANCE

.1 **Codes and Standards:** Refrigerant piping systems are to be in accordance with CSA B52, Mechanical Refrigeration Code, and any applicable local Codes and Regulations.

.1 Refrigerant piping registration, with regards to air conditioning systems, is required for systems with a capacity greater than 5 tons (18 kW).

.2 Refrigerant piping installing contractor is to be certified by Technical Standards and Safety Authority (TSSA). Installing contractor is to install refrigerant piping in accordance with manufacturer's installation instructions and in accordance with local codes. Contractor is responsible for all regulatory approvals, if required. Upon completion of installation, documentation of refrigerant amount, test certificates and verification documentation, etc., is to be provided in a binder, in accordance with requirements of local authorities having jurisdiction.

.3 **Installation Personnel:** Refrigerant piping and direct expansion refrigeration equipment must be installed by or under direct on site supervision of a licensed journeyman refrigeration mechanic.

Part 2 - Products

2.1 PIPE, FITTINGS AND JOINTS

.1 Type ACR hard drawn seamless copper refrigerant tubing to ASTM B280, factory degreased, dehydrated and capped or nitrogen filled and capped, complete with factory washed and bagged wrought copper soldering fittings to ASME B16.22, and brazed joints made with high melting point silver brazing alloy conforming to AWS Classification BcuP-5.

2.2 PIPING LINE SETS

.1 Equal to Great Lakes Copper Inc. "EZ-Roll" soft annealed copper to ASTM B280, suitable for use with the refrigerant involved, factory cleaned and capped, and with sizes and lengths as required.

2.3 GENERAL RE: VALVES AND PIPING SPECIALTIES

.1 All refrigerant valves and piping specialties specified below are to factory cleaned, degreased, and supplied to the site with capped ends.

2.4 **SHUT-OFF VALVES**

.1 **Ball Valves**: Mueller Industries Inc. "Ballmaster", 1/4 turn, CSA certified forged brass ball valves, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with carbon filled Teflon ball seals, two O-ring stem seals, a gasketed seal cap, a flow direction arrow cast into the body, a ball position indicator on the stem, and extended copper tube connections to permit brazing the valve into the line without disassembling the valve.
Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

.2 **Diaphragm Valves:** Mueller Industries Inc. "Linemaster" forged brass, frost-proof, Type 1 Series, CSA certified packless diaphragm valves, each suitable for a 3445 kPa (500 psi) working pressure and complete with an O-ring to prevent moisture from entering the diaphragm chamber, one phosphor bronze and two stainless steel diaphragms, and extended copper tube brazing connections.
Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.5 **CHECK VALVES**

.1 Mueller Industries Inc. "Checkmaster" straight through type for valves 6.4 mm to 16 mm (1/4" to 5/8") diameter, globe type for valves 22 mm (7/8") diameter and larger, each complete with extended tubing for brazing connections, and as follows:

.1 straight through type check valves are to be complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat;

.2 globe type check valves are to be complete with a cast bronze body, forged brass cap, phosphor bronze spring, Teflon seat disc, and neoprene O-ring seal.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.6 **PIPING TRAPS**

.1 Mueller Industries Inc. Style No. WE-554P brazing end copper "P" traps.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.7 **PRESSURE VESSEL RELIEF VALVES**

.1 Mueller Industries Inc. "Safetymaster", factory set pressure relief valves, straight through or angle type as required, each constructed in accordance with requirements of ANSI Code B9.1 and the ASME Code for Unfired Pressure Vessels, and each complete with a brass body, neoprene seat disc, and lead seal and locking wire.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.8 REFRIGERANT LIQUID MOISTURE INDICATORS

.1 Mueller Industries Inc. "Vuemaster", forged brass, triple sealed, CSA certified liquid moisture indicators, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with a liquid indicator which shows "FULL" when the system is fully charged with refrigerant and remains blank when there is a restriction or shortage of refrigerant in the liquid line, a moisture indicator which changes colour from blue to pink when moisture is present in the system, a plastic dust cover, and extended copper tube brazing connections.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.9 LIQUID LINE FILTER-DRIER

.1 Mueller Industries Inc. "Drymaster Micro-Guard" CSA certified filter-driers, each suitable for a maximum 3445 kPa (500 psi) working pressure and complete with a combination of desiccants in a fluted briquette for drying, and a fluted briquette type filter.

.2 Acceptable manufacturers are:

.1 Mueller Industries Inc.;

.2 Sporlan Valve Co.;

.3 Superior Refrigeration Products/Sherwood.

2.10 FLEXIBLE PIPING CONNECTIONS

.1 Senior Flexonics Canada "VIBRA-SORBERS" phosphor bronze construction, factory cleaned, dried, and sealed flexible piping connections with copper tube brazing ends.

.2 Acceptable manufacturers are:

.1 Senior Flexonics Canada;

.2 The Metraflex Co.

2.11 ELECTRONIC EXPANSION VALVES

.1 Factory tested, mechanically driven by stepped motor that receives its drive signals from a separate control board hard-wired to the valve.

.2 Acceptable manufacturers are:

.1 Bitzer Canada Inc.

2.12 LEAK DETECTION SYSTEM

.1 Contractor to provide leak detection system as required based on the refrigerant system size, space, equipment layout and reviewed & approved, by the equipment supplier.

Part 3 - Execution

3.1 **INSTALLATION OF REFRIGERANT PIPING, VALVES AND SPECIALTIES**

.1 Refrigerant piping shall not be installed vertically through floors from one storey to another, except where the piping is enclosed in an approved rigid and tight continuous fire-resistant chase or pipe that is completely sealed to floors not served by the refrigeration system. The chase or pipe shall be vented to the outdoors.

.2 Provide all required refrigerant piping. Piping is to be type ACR copper with wrought copper fittings. Install piping in accordance with requirements of reviewed refrigerant piping schematics referred to in Part 1 of this Section.

.3 Make all refrigerant piping joints using a light coat of approved brazing flux applied to both pipe and fitting. Do not use acid flux. During the brazing process, ensure that the pipe and fittings are kept full of nitrogen or carbon dioxide to prevent scale formation inside the pipe and fitting.

.4 Where shown or specified, use soft copper refrigerant piping line sets.

.5 Provide shut-off valves to isolate each piece of equipment if shut-off valves are not supplied integral with the equipment. Shut-off valves inside the building are to be ball or diaphragm type. Shut-off valves outside the building are to be diaphragm type.

.6 Provide a refrigerant charging valve for each system if such a valve is not supplied integral with the equipment.

.7 Provide all refrigerant piping accessories shown and/or required and install in accordance with the manufacturer's recommendations.

.8 Provide all required refrigerant.

.9 Provide flexible connections at piping connections to roof mounted condensing units. Install in accordance with the manufacturer's instructions.

.10 Provide expansion valves where shown and/or required, each matched to the coil and installed in accordance with the manufacturer's instructions.

.11 All field assembled piping shall be leak tested using dry nitrogen at a minimum pressure of 30 psig for a minimum 24 hours prior to evacuation and charging insulating any refrigerant lines and prior to refrigerant line being enclosed by the building construction.

.12 Test each joint in the refrigeration piping for leaks using at least one of the following methods;

- .1 Bubble test
- .2 Electronic leak detector
- .3 Halide leak detector
- .4 Ultrasonic leak detector
- .5 Repair all leaks and repeat the pressure test until the system holds pressure.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Cleaning of pipe and fittings.

.2 Chemical feeder equipment.

.3 Chemical treatment.

1.2 RELATED SECTIONS

.1 Section 25 50 02 - Digital Control Equipment.

.2 Section 23 21 00 - Hydronic Piping: Placement of water coupon rack, by-pass (pot) feeder.

.3 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 CSA (Canadian Standards Association).

.4 UL (Underwriters Laboratories Inc.).

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

.3 Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

1.5 SUBMITTALS FOR INFORMATION

.1 01 33 00 - Submittal Procedures.

.2 Installation Data: Manufacturer's special installation requirements including placement of equipment in systems, piping configuration, and connection requirements.

.3 Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

.4 Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.

1.6 CLOSEOUT SUBMITTALS

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Maintenance Contracts:

.1 Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.

.2 Provide four (4) monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

.3 Provide laboratory and technical assistance services during this maintenance period.

.4 Include one (1) hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.

.5 Coordinate with the Commissioning Agent.

.6 Provide onsite inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

.3 Record Documentation: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

.4 Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials: Provide sufficient chemicals for treatment and testing during warranty period.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) documented experience. Company to have local representatives with water analysis laboratories and full time service personnel.

.3 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience.

1.9 **REGULATORY REQUIREMENTS**

.1 Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for to public sewage systems.

Part 2 - Products

2.1 **MANUFACTURERS**

.1 Design is based on Dearborn

.2 Acceptable Products:

.1 Dearborn

.2 Specialty Chemicals

.3 Drew Chemicals

2.2 **MATERIALS**

.1 **System Cleaner:**

.1 Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tri-poly phosphate and sodium molybdate.

.2 Biocide; Chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

.2 **Closed System Treatment (Hot Water Heating):**

.1 Sequestering agent to reduce deposits and adjust pH; polyphosphate.

.2 Corrosion Inhibitors: Liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.

.3 Conductivity Enhancers: Phosphates or phosphonates.

2.3 **BY-PASS (POT) FEEDER**

.1 By-Pass (Pot) Feeder: 6.8 L (1.8 gal) quick opening cap for working pressure of 1200 kPa (175 psig).

2.4 **DRIP FEEDER**

.1 Plastic reservoir with coil of capillary tubing with probe, weight, charging syringe, and clip.

2.5 **WATER METER (BOILER MAKE-UP)**

.1 Displacement type cold water meter with sealed, tamper-proof magnetic drive, impulse contact register single pole, double throw dry contact switch.

2.6 **SOLENOID VALVES**

.1 **Valves:** Forged brass body globe pattern, normally open or closed as required, [general purpose] [explosion- proof and watertight] solenoid enclosure, and continuous duty coil.

.2 Electrical Characteristics:

.1 120 Volts, single phase, 60 Hz.

2.7 **TEST EQUIPMENT**

.1 Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 0.135 to 0.338 ml (4 to 10 oz.) zeroing titrating burettes and associated reagents.

.2 Provide the following test kits:

.1 Alkalinity titration test kit.

.2 Chloride titration test kit.

.3 Sulphite titration test kit.

.4 Total hardness titration test kit.

.5 Low phosphate test kit.

.6 Conductivity bridge, range 0 - 10,000 microohms.

.7 Creosol red pH slide complete with reagent.

.8 Portable electronic conductivity meter.

.9 High nitrite test kit.

2.8 **PRE-OPERATIONAL CLEANING OF NEW HEATING WATER SYSTEMS**

.1 Flush out piping systems after pressure test for a minimum of four (4) hours.

.2 Fill and back flush hot water heating pipe and radiation to mains.

.3 Fill and thoroughly flush new hot water heating pipe systems with a 1" (25 mm) diameter hose, every 100'-0" (30500 mm), connected to the domestic cold water system, complete with isolation valve and backflow preventer. Provide valved connections and all hoses. Upon completion of the flush out procedure, remove backflow preventer and cap pipe.

.4 When declared clean by the Water Treatment Company, circulate cleaner equal to Dearborn No. 345 cleaner at a dosage of 100 lb/1000 gallon (45 kg/4500L) system water for a period of 72 hours. This is cold water cleaner and can be used at water temperatures 50°F to 150°F (10°C to 65°C).

.5 At completion of a circulating period, system shall be drained and flushed with fresh water for a period of four (4) hours. Blow down drains of all duct mounted heat coils. Blow down drains at all system low points. The flushing of each low point shall be completed by flushing first with the supply valve open, return valve closed, and then the return valve open, supply valve closed. All strainers and filters shall be opened and cleaned. Chemical Treatment Company must approve flushing test at end of the cleaning period. Cleaning shall continue until system is accepted. Provide 24 hours advance notice.

.6 Each system shall be filled with clean water to give 7.6 pH in boiler system. Supply necessary chemicals to give above pH value. Chemicals must be approved by Ontario Ministry of Environment for this use and disposal.

.7 During cleaning operation, runtal units shall be disconnected and their hose connections used to by-pass water around each unit. Operate heating boiler to maintain 95°F (35°C) system water temperature. DO NOT EXCEED 109°F (43°C).

.8 Install treatment feeders for each piping system. Mount each feeder in by-pass around pumps in accordance with Manufacturer's directions. Provide valves and unions not supplied by Manufacturer.

.9 Charge system 20 lb/1000 gallons (9 kg/4500L) to give a Molybdate concentration of 70 ppm. Provide test kits for chemical treatment systems and instruct Owner's staff in their use. Provide monthly inspections over the Two-year warranty period to check system. Issue a monthly report to the Owner and the Consultant.

.10 Water Treatment Supplier to prepare final report on the system condition after all flushing and charging is complete.

2.9 **CLEANING & FLUSHING**

.1 The Water Treatment Company will supervise the entire cleaning and flushing operation of the system and witness the following:

.1 The system is flushed of all sand, gravel, and filings before cleaner is added.

.2 The proper strength of cleaner is added and circulated for the prescribed time.

.3 The system is thoroughly flushed again before chemicals are added.

.4 The proper dosage of chemicals is added.

.5 Cartridge filters are replaced at the proper intervals.

.2 Provide written confirmation to the Consultant that the above was completed.

Part 3 - Execution

3.1 **PREPARATION**

.1 Systems to be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

.2 Place terminal control valves in open position during cleaning.

.3 Verify that electric power is available and of the correct characteristics.

3.2 **CLEANING SEQUENCE**

.1 **Concentration:**

.1 As recommended by manufacturer.

.2 1 kg per 1000 L (1 lb per 100 gal) of water contained in the system.

.3 1 kg per 1000 L (1 lb per 100 gal) of water for hot systems

.2 **Hot Water Heating Systems:**

.1 Apply heat while circulating, slowly raising temperature to 71 degrees C (160 degrees F) and maintain for twelve (12) hours minimum.

.2 Remove heat and circulate to 37.8 degrees C (100 degrees F) or less; drain systems as quickly as possible and refill with clean water.

.3 Circulate for six (6) hours at design temperatures, then drain.

.4 Refill with clean water and repeat until system cleaner is removed.

.3 Use neutralizer agents on recommendation of system cleaner supplier and approval of Consultant.

.4 Flush open systems with clean water for one (1) hour minimum. Drain completely and refill.

.5 Remove, clean, and replace strainer screens.

.6 Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 **INSTALLATION**

.1 Provide adequate clearance to permit performance and servicing and maintenance of equipment.

.2 Pipe all drains and reliefs to nearest floor drain.

.3 Install pot feeder for each system. Mount each feeder in by-pass around pumps in accordance with manufacturer's direction. Provide valves and unions which are not supplied by manufacturer.

.4 Install cartridge filters for each system. Mount each filter in by-pass around pumps in accordance with manufacturer's directions. Provide valves and unions which are not supplied by manufacturer.

.5 Chemicals must be approved by the Ontario Ministry of the Environment for this use and disposal.

.6 Supply and install every 100'-0" (30 meters) on heating water pipe system, high capacity hose connections for high velocity flushing.

3.4 **WARRANTY PERIOD**

.1 Provide initial review of system connection and water analysis. Recommend treatment dosages.

.2 Provide the services of the Water Treatment Company Representative for start-up assistance to instruct personnel in the use of chemicals.

.3 Provide system review and treatment analysis, reports, charts and log sheets every 90 calendar days during the warranty period.

.4 Provide all necessary laboratory and technical assistance.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Metal duct work.

.2 Casing and plenums.

.3 Duct cleaning.

1.2 RELATED SECTIONS

.1 Section 01 11 00 - General Instructions & Summary of Work: Owner provided equipment.

.2 Section 03 30 00 - Cast-in-place Concrete.

.3 Section 09 91 22 - Painting: Weld priming, weather resistant, paint or coating.

.4 Section 23 05 29 - Supports and Anchors: Sleeves.

.5 Section 23 05 93 - Testing, Adjusting, and Balancing.

.6 Section 23 07 13 - Duct Insulation: External insulation and duct liner.

.7 Section 23 33 00 - Duct Work Accessories.

.8 Section 23 36 00 - Air Terminal Units.

.9 Section 23 37 00 - Air Outlets & Inlets.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ASTM A90/A90M - Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

.4 ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.5 ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.

.6 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.7 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.

.8 ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

.9 ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.10 ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.11 NFPA 90A - Standard for Installation of Air Conditioning and Ventilating Systems.

.12 NFPA 90B - Standard Installation of Warm Air Heating and Air-Conditioning Systems.

.13 SMACNA 1884-2003 - Fibrous Glass Duct Construction Standards.

.14 SMACNA 016 - HVAC Air Duct Leakage Test Manual

.15 SMACNA 1966-2005 - HVAC Duct Construction Standards - Metal and Flexible.

.16 UL 181-2013 - Standard for Factory-Made Air Ducts and Air Connectors.

1.4 **PERFORMANCE REQUIREMENTS**

.1 No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts to ASHRAE table of equivalent rectangular and round ducts.

1.5 **SUBMITTALS FOR REVIEW**

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide data for duct liner, duct connectors, duct materials.

.3 Shop Drawings: Indicate duct fittings, particulars such as gauges, and configuration prior to start of work for the following systems.

.1 1000 kPa (4 inch) pressure class and higher.

1.6 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA 1966.

.3 Installation Data: Manufacturer's special installation requirements including special procedures for glass fibre ducts.

.4 Manufacturer's Certificate: Certify that installation of glass fibre duct work meet or exceed specified requirements.

1.7 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Perform Work to - HVAC Duct Construction Standards - Metal and Flexible.

.3 Maintain one (1) copy of document on site.

.4 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

.5 Installer Qualifications: Company specializing in performing the work of this section with minimum three (3) years documented experience.

1.9 **REGULATORY REQUIREMENTS**

.1 Construct duct work to NFPA 96 standards.

1.10 **ENVIRONMENTAL REQUIREMENTS**

.1 Ambient Conditions:

.1 Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

.2 Maintain temperatures during and after installation of duct sealants.

Part 2 - Products

2.1 **RECTANGULAR LOW PRESSURE DUCT MATERIALS**

.1 For the purpose of this specification low pressure ductwork is to be ducted for systems below 2" (500 Pa) static pressure. This includes all ductwork indicated on the Drawings with the exception of that indicated in other parts of this section. Duct shall be fabricated to SMACNA Duct Construction Standards, Section No. 1, and as follows:

.1 HVAC Duct Construction Standards - Metal and Flexible - latest edition.

.2 HVAC Duct Leakage Test Manual - latest edition.

.2 Ductwork shall be constructed to withstand 1-1/2 times the working static pressure with a leakage rate of 5% maximum and designed to operate at 1-1/2" w.g. (373 pa) maximum pressure.

.3 Fabricate ducts from smooth finish prime grade, new, open hearth, soft steel sheet, galvanized, conforming to manufacturer's standard thickness as specified herein.

.4 All sides of ducts over 10" (254 mm) in either dimension, to have all sides cross-broken or beaded at 12" (300 mm) spacing, except area of the duct where outlets are to be installed.

.5 Thickness & Reinforcing of Sheet Metal Ductwork, Material & Thickness:

Largest Duct Dimension	**Steel Thickness Gauge (mm) Duct**	**Steel Thickness Gauge (mm) Slip**	**Aluminum Thickness Gauge (mm) duct**	**Recommend construction Transverse joints slip**
Up to 12" (300 mm)	26 (0.551)	26 (0.551)	24	Flat drive cleat on side, flat s cleat on top and bottom. Joints on 96" (2440 mm) centres max.
13" to 20" (330 mm to 508 mm)	24 (0.701)	26 (0.551)	22	Flat drive cleat on side, 1" (25 mm) standing s cleat on top and bottom. Joints on 72" (1819 mm) centres max.
21" to 30" (533 mm to 762 mm)	24 (0.701)	26 (0.551)	22	Flat drive cleat on sides up to 20" (508 mm), and 1" (25 mm) standing drive slip over 20" (508 mm). Top and bottom 1" (25 mm) standing s cleat. Joints on 48" (1219 mm) centres maximum.

Largest Duct Dimension	Steel Thickness Gauge (mm) Duct	Steel Thickness Gauge (mm) Slip	Aluminum Thickness Gauge (mm) duct	Recommend construction Transverse joints slip
31" to 48" (787 mm to 1219 mm)	22 (0.853)	22 (0.853)	20 (1.01)	Flat drive cleat on sides up to 20" (508 mm), and 1" (25 mm) standing drive slip up to 30" (762 mm), and 1" gasketted and bolted formed flange over 30". Top and bottom 1" (25 mm) standing s cleat. Joints on 48" (1219 mm) centres maximum. *(* stays if required.)
49" to 60" (1245 mm to 1529 mm)	20 (1.01)	20 (1.01)	18 (1.16)	Flat drive cleat on sides up to 20" (508 mm), and 1" (25 mm) standing drive slip up to 30" (762 mm), and 1" gasketted and bolted formed flange over 30". Top and bottom 1-1/2" (40 mm) gasketted and bolted formed flange. Joints on 48" (1219 mm) centres maximum.

.6 The Contractor at his own discretion may also use flange duct joints; Ductmate or Nexxus.

.7 All bends or elbows shall be made with a radius of not less than 1-1/2 times the width of the duct. Where this is not possible, turning vanes shall be used. Vanes shall be of single vane construction with 1-1/2" (40 mm) space up to 24" (600 mm) width, and 3" (80 mm) spacing over 24" (600 mm).

.8 Branch mains shall be connected to the main duct as specified for ductwork. "T" connection shall be made using a clinch lock.

.9 Acoustical Liner: Ducts are to be increased in size by thickness of insulation added to maintain inside dimensions as per indicated duct sizes and to ensure no increase in duct design velocity.

2.2 **CIRCULAR DUCT & FITTINGS, SINGLE-WALL**

.1 For the purpose of this specification low pressure ductwork is to be ducted for systems below 2" (500 Pa) static pressure. This includes all ductwork indicated on the Drawings with the exception of that indicated in other parts of this section. Duct shall be fabricated to SMACNA Duct Construction Standards Section No. 1 (latest edition).

.2 All round duct through 26" (660 mm) diameter shall be United Sheet Metal Spiral lock-seam Uni-Seal duct manufactured from galvanized steel meeting ASTM A-527-71 in the following gauges:

Diameter	Metal Thickness	
3" - 7" (76 - 175 mm)	28 ga.	0.01" (0.40 mm)
8" - 14" (203 - 350 mm)	26 ga.	0.022" (0.551 mm)
15" - 26" (381 - 660 mm)	24 ga.	0.028" (0.701 mm)
27" - 35" (685 - 875 mm)	22 ga.	0.022" (0.851 mm)
36" - 52" (900 - 1325 mm)	20 ga.	0.016" (1.0 mm)

.3 All fittings shall be United Sheet Metal standard Uni-Form fittings manufactured from galvanized steel meeting ASTM A-527-71 with continuous weld or standing seam construction with fitting gauge and thickness equal to or thicker than the downstream duct section with which they are mated.

.4 All 90 degree T Connections shall have machine formed radiused entrances (laminar flow) on tees to 16" (406 mm) diameter taps off of 18" (457 mm) diameter bodies and machine-rolled (pull-through) entrances on tees to 24" (600 mm) diameter taps off of 24" (600 mm) diameter bodies.

.5 All 45 degree laterals shall have machine rolled (pull through) entrances on laterals to 12" (300 mm) diameter taps.

.6 Elbows shall be fabricated to a centre-line radius of 1.5 times the cross-section diameter.

.7 Sleeve couplings to be used for pipe-to-pipe joints. Insertion length of sleeve couplings and fitting collar shall be 2" (50 mm) for ducts up to 9" (225 mm) diameter and 4" (100 mm) for ducts 10" (250 mm) and over in diameter.

.8 Longitudinal joints shall be lapped and pressure rolled air tight. All seams, end joints and fittings are to be sealed with duct sealer. Duct sealer to be "United" duct sealer, 3-M, Tough Bond or Duro Dyne S-2.

.9 All elbows, not die-stamped, shall be fabricated according to the following schedule:

Elbow Angle	Number of Gores
Less Than 35 Deg.	2
36 Deg. Through 71 Deg.	3
Over 71 Deg.	5

2.3 **FLEXIBLE DUCT**

.1 Flexible duct shall be acoustic type complete with perforated aluminum core, 1" (25 mm) insulation and outer mylar sleeve. OR

.2 The flexible duct shall be rated for a maximum working velocity of 2500 FPM (12.7 m/s) and 4" (1500 Pa) W.C. pressure and be listed by Underwriters Laboratories under their UL-181 Standards as Class I, Air Duct and shall comply with NFPA Standard No. 90A.

.3 Flexible duct shall be maximum 6'-0" (1800 mm) and minimum 3'-0" (900 mm). Install with a minimum number of bends.

.4 Connection to branch ducts shall be made with spin-in collars. Joints shall be sealed duct type and secured to the duct with metal screw-type bands. Spin-on collars shall be complete with balancing damper.

.5 Flexible ductwork sizes shall match diffuser neck size.

.6 Design based on Flexmaster Nova Flex Group - Type T/L-A

.7 Acceptable Products:

.1 Alpha-Flex

.2 Cana-Flex

.3 Automation Industries

.4 Nova Flex Group - Flexmaster

2.4 **DUCT/PLENUM PROTECTIVE EDGE**

.1 Supply and install on all edges a pre-formed, galvanized 1-1/2" x 1-1/2" (40 mm x 40 mm) x 16 gauge, 90 degree protective edge.

.2 Protective edges to be installed after insulation has been applied and before canvas covering.

.3 See Duct Insulation.

2.5 **HANGERS**

.1 Horizontal ductwork up to 29" (740 mm) wide shall be supported by galvanized 1" (25 mm) 16 gauge or heavier hangers placed not over 6'-0" (1800 mm) apart, with ends turned under the duct. Secure to duct with sheet metal screws, two (2) per side, and one (1) in bottom.

.2 Horizontal ductwork 30" (760 mm) wide and over shall rest on galvanized angle iron supports or Unistrut channels, with rod hangers at 6'-0" (1800 mm) spacing as follows:

Duct Size	Rod	Angle
30" to 48" (750 mm to 1200 mm)	1/4" (6 mm)	1-1/2" x 1-1/2" x 1/8" (40 mm x 40 mm x 3 mm)
49" to 72" (1225 mm to 1825 mm)	3/8" (9 mm)	1-1/2" x 1-1/2" x 1/8" (40 mm x 40 mm x 3 mm)
73" to 84" (1850 mm to 2130 mm)	3/8" (9 mm)	1-5/8" x 1-5/8" x 3/16" (45 mm x 45 mm x 5 mm)

.3 Flexible duct shall be hung as per horizontal ductwork up to 29" (740 mm) wide.

2.6 **CONDENSATE DRAIN PANS (ELECTRICAL ROOMS)**

.1 Fabricate pan from smooth finish, prime grade, new, open hearth & soft steel.

.2 Pan to be constructed with 22 gauge galvanized sheetmetal complete with leak-proof joints/seams and 50 mm (2") high lip.

.3 Pan to be size of room minus 2" (50 mm) on each side. Pan to be hung from structure. See room dimensions on Architectural Drawings.

.4 Pan to be complete with 40 mm (1-1/2") drain pipe to spill into nearest floor drain.

Part 3 - Execution

3.1 **DUCT INSTALLATION - GENERAL**

.1 In general, all ducts to be constructed that they may be dismantled and cleaned. All visible internal portions of duct outlets behind grilles and registers to be painted dull black.

.2 Before installing ductwork, registers, grilles and diffusers, this Contractor shall check for interference with the work of others, so that grouped ducts, pipes and conduits will not interfere with each other, and that registers, grilles and diffusers are correctly located. See Architect's Reflected Ceiling Plans for final location of grilles, diffusers and sprinkler heads. Prepare interference Drawings before fabricating ductwork. DO NOT USE FLEXIBLE DUCT IN ROOMS WITH NO CEILING.

.3 Install ductwork essentially as shown, in strict adherence to the ceiling heights indicated on the Architectural Drawings. Architect reserves the right to vary run and shape of ducts and make offsets during the progress of the work as required, to avoid structural or other interferences.

.4 Ductwork concealed in building construction shall be installed in time so as not to cause delay to the work of other trades, and in ample time to perform tests as required. Concealed ducts shall not be built-in until approval for them has been obtained from the Consultant. Make sheet metal connections to masonry as required for air inlets and exhaust, airtight and weathertight.

.5 Prepare Shop Drawings, dimensions and locating wall, floor and roof slab openings in ample time to meet the building construction schedule. Field check and approve the size and locations of openings prior to placement of concrete or masonry. Openings required at a later date shall be at this Contractor's expense.

.6 Interference Drawings shall be provided when the Contractor is supplying alternate equipment in lieu of the specified items in areas shown as Mechanical and Boiler Rooms, etc. He shall provide dimensioned Drawings of the equipment location, showing clearances to walls, ceiling, ducts etc., and also indicate clearances for filter and coil removal etc.

3.2 **DUCTWORK**

.1 Supply and install ductwork and plenums shown and required to complete duct systems and put each in operating condition. Mechanical Drawings indicate general location and route of ductwork to be installed. General layout of ducts may be taken from Drawings, but this Section is responsible for avoiding interferences with other Sections not specifically shown on Mechanical Drawings. Actual measurements shall be taken at building before ductwork is fabricated.

.2 Make without additional charge, any necessary changes or additions to layout of ductwork to accommodate structural, duct, piping, ceilings, electrical or equipment conditions. Where openings in walls for ductwork have been Provided by others, make full use of such openings by fabricating ductwork to fit them, or if necessary, Provide offsets and transitions to suit. Location of ducts may be altered if change is made before installation is approved by the Consultant, and does not cause Owner or other Sections any extra expense.

.3 Install in ductwork where shown or required, controls, motorized dampers, coils, filters, etc., in accordance with installation instructions supplied by Equipment Supplier.

.4 Supply and install where required to suit system balancing, Lawson-Taylor Pitot Tube openings covers in ductwork for each supply, return and exhaust system. Provide openings at all supply fan discharges and exhaust fan inlets. Locate 15 mm (1/2") openings in straight duct runs to facilitate entry of pitot tube. Provide a minimum of three (3) holes per duct at each of the above locations, and at not more than 18" (450 mm) centres. Openings shall be concealed after tests by this Division.

.5 After final adjustments are made for air handling systems, lock each control device in position and visually indicate required setting. for balancing dampers, Provide additional locking screw or bolt to approval.

.6 During construction, temporarily seal open ends of ductwork to exclude entry of foreign material and construction dust.

3.3 **HANGERS**

.1 Low pressure ductwork shall have substantial hangers attached to the structure with concrete inserts to secure the ducts in place and prevent vibration. No caddy clips or plumber's tape permitted for hanging ducts. DO NOT SUPPORT FROM METAL DECK.

3.4 **QUIET OPERATION**

.1 Each system has been designed to be quiet in operation, N.C. 35 maximum. It is the responsibility of this Section to supply equipment and to install same, ductwork, etc., to ensure noise levels will be maintained to the satisfaction of the Consultant.

3.5 **OUTDOOR/EXHAUST AIR WALL PLENUMS**

.1 Reinforce and brace plenums to SMACNA Duct Construction Standard.

.2 Form bottom of plenum without seams or with a minimum number of seams. Weld bottom side joints. Weld transverse joints and caulk.

.3 Slope bottom of plenum down towards louvre/block vent to allow water to drain out of plenum.

3.6 **VRF AIR CONDITIONING UNITS & FAN COIL UNITS**

.1 Division 23 shall install units.

.2 Units will be complete with duct collars.

.3 Connect ductwork to duct collars through a flexible connection.

3.7 **DUCTWORK CONSTRUCTION**

.1 Ducts up to 24" (600 mm) in either dimension to have reinforcing ribs, spaced not more than 8'-0" (2400 mm) apart.

.2 Ducts over 24" (600 mm) in either dimension to have reinforcing ribs, spaced not more than 4'-0" (1200 mm) apart. Ducts shall have supplemental stiffening as required to prevent drumming and provide a structurally sound assembly.

3.8 **CHANGES IN SHAPE OR DIMENSION**

.1 Slope requirements for transformations that either increase or decrease duct area to a minimum of 1:7.

.2 The angle of transformation at connections to heaters or other equipment is not to exceed 30 degrees from a line parallel to the airflow on the approaching side of the equipment, and 45 degrees on the leaving side of the equipment. The angle of approach may be increased to meet space conditions when the transformation section is provided with vanes.

3.9 **CHANGES IN DIRECTION**

.1 Changes in direction and shape shall be kept to the minimum, permitted by distribution requirements and building conditions. Turns to be made with these elbows as required in the following order of preference on all supply, return and exhaust ductwork.

.2 Unvaned elbow, throat radius 3/4 width of duct and full heel radius.

.3 Elbows with inside radius less than 3/4 width of duct but not less than 3" (80 mm) and full heel radius and single thickness turning vanes

.4 Square elbow with single thickness turning vanes spaced at 1-1/2" (40 mm) centres up to 24" (600 mm) duct and 3" (80 mm) centres over 24" (600 mm).

3.10 **BALANCING DAMPERS**

.1 Splitter or opposed blade dampers for adjustment of air distribution to respective branches to be located as indicated on Drawings, or as described in other parts of this specification.

3.11 **SEAMS**

.1 Sections to be assembled with Pittsburgh lock or grooved longitudinal seams, fully closed for tightness and appearance.

3.12 **JOINTS & REINFORCEMENT**

.1 Duct sections to be jointed by flat "S" or Standing "S" cleats which conform to following general requirements:

.1 Ducts up to 18" (450 mm) in width to have flat "S" cleats on top and bottom and drive cleats on sides.

.2 Ducts over 18" (450 mm) width to have standing "S" cleat on top and bottom and drive cleat on sides.

.3 Where length of drive cleat exceeds 24" (600 mm), a standing "S" or standing "T" cleat to be used and corners taped for tightness.

3.13 **SUPPORTING OF DUCTS**

.1 All ducts to be adequately supported. for ducts up to 18" (457 mm) in width, hangers to be placed on not more than 8'-0" (2400 mm) centres; ducts 19" (475 mm) and above in width on not more than 48" (1200 mm) centres. Hangers to be placed plumb and present a neat appearance.

.2 Hangers on ducts up to 36" (900 mm) in width to be constructed from galvanized band iron 1" x 16 gauge (25 mm x 1.6 mm). On ducts 37" (925 mm) and above in width, hangers to be constructed from galvanized iron angles not less than 1-1/2" x 1-1/2" x 1/8" (40 mm x 40 mm x 3 mm). Hangers to extend down the sides of the ducts to bottom of duct with angle bent around bottom for support. Fasten to duct with sheet metal screws on sides and bottom. Hangers on ducts to be of same material as ductwork. Supply and install high velocity sealant on all sheetmetal screws.

.3 Hangers bands to extend the full depth of duct with bottom of hanger being toed in under duct. Hangers to be attached to the duct using not less than three rivets or metal screws. Supply and install high velocity sealant on all sheetmetal screws.

.4 On reinforced concrete, all hangers for ductwork to be fastened to the concrete by Ram-Set studs or expansion shields and lag bolts.

.5 Ducts cannot in any location, be supported from the furring, ceiling construction, piping, conduit or other ducts.

.6 The use of perforated band iron for supporting of ducts is not permitted.

.7 In Mechanical Rooms, at approved locations where ducts are supported from the floor, install galvanized angle irons with base plates anchored to floor slab. Supports to be placed so as not to interfere with access to or around equipment and be attached to the floor slab.

3.14 **REINFORCING OF SHEET METAL**

.1 All ductwork 12" (300 mm) and over in either dimension to be cross broken except those to which internal rigid board insulation is applied. Where drive cleat is used, top and bottom corners to be caulked before cleat is turned over to make duct air tight.

.2 All other joints to be caulked at all corners before and after joint is made to make duct completely air tight.

.3 All standing "S" cleats referred to are to be machine made for purposes of extra reinforcing.

.4 All longitudinal seams are to be Pittsburgh lock seam hammered over and made air tight.

.5 Where a duct falls into certain maximum duct size classification the entire duct, sides top and bottom, is to be of the gauge specified.

.6 Sheet metal screws to be used on sides of ducts where standing "S" cleat is used or reinforcing angle on 12" (300 mm) centres or minimum 2 screws per side.

3.15 **SHEET METAL INSTALLATION**

.1 During installation, the open ends of ducts shall be protected to prevent debris and dirt from entering. The Prime Mechanical Contractor to install this work in accordance with the overall approved progress schedule and in co-operation with all other Contractors so there is no delay to other trades.

.2 All necessary allowances and provisions to be made in the installation of the ducts for the structural conditions of the building and other trades, and ducts to be transformed or divided as may be required. Ductwork to be altered or modified so as to give an effective sectional area equal to that originally shown without exceeding an aspect ratio of 4:1. All of these changes, however, must be approved and installed as directed at the site, or as approved on shop or erection Drawings, and at no additional cost.

.3 All exposed spiral ducting to be installed in a neat manner with each section overlapping the next and all exposed edges sealed.

.4 All exposed ducting to be supported from a single hanger rod with support plate on inside of duct.

3.16 **SPECIAL BRACKET**

.1 Where the method of support specified above is not applicable, vertical risers and other duct runs, in general, to be supported by substantial angle brackets designed to meet field conditions.

3.17 **DUCTS AT MASONRY**

.1 Where ducts are shown connecting to or terminating at masonry openings, and/or along the edges of all plenums at floors, walls, ceilings, etc. Provide a continuous 1-1/2" x 1-1/2" x 1/8" (40 mm x 40 mm x 6 mm) galvanized angle iron bolted to the construction and made air tight to same by applying approved caulking compound on the angle before they are drawn down tight. The sheet metal at these locations to be bolted to the continuous angle iron.

3.18 **LOCATION OF OUTLETS**

.1 The position of all outlets shown on the Drawings are approximate only and this Contractor is to check the location of all outlets with the Consultant and make such adjustments in position as are necessary to conform with architectural features, acoustic tile pattern, etc. and the outlets required by other trades without extra charge. Ceiling outlets and their assemblies to be constructed so that they fit the spacing and manufacture of the removable acoustic ceiling.

3.19 **OUTSIDE OPENINGS**

.1 Unless specifically noted otherwise, openings in the outside walls, roof, etc. to be left for this Contractor, where shown and required for fresh air intakes and exhausts.

.2 Louvres, birdscreens, etc. for these intakes and exhausts, to be supplied by Division 10 and installed by this Division. Supply and install all necessary ductwork and plenums for intakes and exhausts and patch around same to make a weather tight job. Co-operate with all other trades on exact location of these openings, ducts, and louvres, serving the air systems. Supply and install 14 ga. insulated louvre blank-offs where shown for blanking off unused portion of louvres.

3.20 DUCT ACCESS DOORS

.1 Install access doors to fire or other dampers, for service, inspection, any other normal maintenance requirements, and for cleanouts where required on specialty systems. Ensure that such access doors are of a size that equipment to be attended is accessible.

.2 Install an access door on the upstream side of each duct mounted heating coil.

3.21 TURNING VANES

.1 Install small arc air foil vanes in ducts at elbows where centre-line radius is less than 1-1/4 times turning dimension of duct.

.2 Square elbows with turning vanes equal to Duro Dyne single thickness vanes spaced at 1-1/2" (40 mm) centres up to 24" (600 mm) duct and 3" (80 mm) centres over 24" (600 mm). Rovane duct turning vanes are acceptable.

3.22 FIRE DAMPERS

.1 Fire dampers are to be installed in all locations shown or where required by the Fire Marshal and to local Authority. Fire dampers are to be labelled by Underwriter's Laboratories, Canada.

.2 Generally where any duct or any outlet passes through any required fire wall, fire separation with a fire resistance rating, or fire rated ceiling the duct to be Provided with an approved automatic fire damper built into the wall. Dampers to be supported from the structure and not from the ducts or grilles, to allow duct drop off under fire conditions.

.3 In addition, install in all systems where ducts service two or more stories, at each floor level approved dampers, leaf dampers, fitted with fusible links of an approved temperature rating to close air tight on linkage failure. Provide access to dampers for linkage replacement.

.4 The complete fire damper installation to be in strict accordance with manufacturers recommendations, NFPA-90A and meet the approval of all authorities having jurisdiction. All smoke and fire damper locations to be shown on Record Drawings.

3.23 FAN-DUCT CONNECTIONS

.1 Install Duro Dyne, Grip-Lock, Durolon duct connectors unless specified otherwise to suit system pressure between ductwork and all fan equipment on both sides to isolate where indicated and on all fan equipment.

3.24 WATERTIGHT DUCT

.1 Provide watertight ductwork for:

.1 Fresh air intakes.

.2 Exhaust air outlets.

.2 Form bottom of duct without longitudinal seams. Solder or weld joints of bottom sheets and sides. Solder or weld transverse joints and caulk.

.3 Slope duct back to exterior louvre and Provide weep holes for drainage.

3.25 **SUPPLY, RETURN & EXHAUST FANS**

.1 All connections to fans to be made utilizing canvas connections as specified under this Section.

.2 All fan systems are to be equipped with all accessories indicated in schedule.

.3 Refer to Division 25 Controls and Instrumentation and Division 26 Wiring Connections, and co-ordinate work.

3.26 **CURBS**

.1 All new prefabricated roof curbs supplied by this Division. All curbs flashed by Roofing Contractor. Refer to details on Drawings.

3.27 **MOTORIZED DAMPERS**

.1 Install all motorized dampers supplied by Division 25 in all locations indicated on the Drawings and described in this Specification, except those dampers supplied as part of a packaged unit.

3.28 **SEALING OF DUCTS**

.1 Seal all seams and joints in all duct systems for an air-tight installation.

.2 Duct sealer shall be high pressure, high velocity water based duct sealer. Apply sealer with either brush or caulking tube.

.3 On exposed duct scheduled for painting, seal only with Product from caulking tube, taking care to maintain a neat, finished appearance to the duct.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Air turning devices/extractors.

.2 Backdraft dampers.

.3 Combination fire and smoke dampers.

.4 Duct access doors.

.5 Duct test holes.

.6 Fire dampers.

.7 Smoke Dampers.

.8 Flexible duct connections.

.9 Volume control dampers.

1.2 RELATED SECTIONS

.1 Section 23 05 48 - Vibration Isolation.

.2 Section 23 31 00 - Duct Work.

.3 Section 23 36 00 - Air Terminal Units: Pressure regulating damper assemblies.

.4 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 NFPA 90A - Standard for Installation of Air Conditioning and Ventilating Systems.

.4 NFPA 92 - Standard for Smoke Control Systems.

.5 SMACNA 1966-2005 - HVAC Duct Construction Standards - Metal and Flexible.

.6 UL 33 - Standard for Heat Responsive Links for Fire-Protection Service.

.7 UL 555 - Standard for Fire Dampers.

.8 UL 555S - Standard for Smoke Dampers.

.9 CSA (Canadian Standards Association).

.10 UL (Underwriters Laboratories Inc.).

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.

.3 Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Manufacturer's special installation requirements including fire dampers and/or combination fire and smoke dampers.

1.6 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of access doors, test holes.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Section 01 78 23: Maintenance and extra material requirements.

.2 Extra Stock Materials: Provide two (2) of each size and type of fusible link.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.9 **REGULATORY REQUIREMENTS**

.1 Products Requiring Electrical Connection: Listed and classified by CSA UL and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.10 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Protect dampers from damage to operating linkages and blades.

Part 2 - Products

2.1 **AIR TURNING DEVICES/EXTRACTORS**

.1 Multi-blade device with blades aligned in short dimension; steel aluminum construction; with individually adjustable blades, mounting straps.

.2 Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with the following:

.1 Push-pull operator strap.

.2 Ceiling mounted rotary operator knob.

.3 Worm drive mechanism with 450 mm (18 inches) long removable key operator.

2.2 **BACKDRAFT DAMPERS**

.1 Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: galvanized steel, with centre pivoted blades of maximum 150 mm (6 inch) width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 COMBINATION FIRE & SMOKE DAMPERS

.1 Fabricate to NFPA 90A and/or UL 555 as indicated.

.2 Provide factory sleeve and collar for each damper.

.3 **Multiple Blade Dampers:** Fabricate with 1.5 mm (16 ga) galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 3.2 x 12.7 mm (1/8 x 1/2 inch) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 12.7 mm (1/2 inch) actuator shaft.

.4 **Operators:** UL listed and labelled spring return. Provide end switches to indicate damper position. Locate damper operator on interior exterior of duct and link to damper operating shaft.

.1 Pneumatic type suitable for operation on 0-140 kPa (0-20 psig) instrument air.

.2 Electric type suitable for 120 Volts, single phase, 60 Hz.

.5 **Normally Closed Smoke Responsive Fire Dampers:** Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.

.6 **Normally Open Smoke Responsive Fire Dampers:** Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.

.7 **Electro Thermal Link:** Fusible link melting at 74 degrees C (165 degrees F); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.4 DUCT ACCESS DOORS

.1 Fabricate to SMACNA 1966, and as indicated.

.2 **Fabrication:** Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. for insulated duct work, install minimum 25 mm (one inch) thick insulation with sheet metal cover.

.1 Less Than 300 mm (12 inches) Square: Secure with sash locks.

.2 Up to 450 mm (18 inches) Square: Provide two (2) hinges and two (2) sash locks.

.3 Up to 600 x 1200 mm (24 x 48 inches): Three (3) hinges and two (2) compression latches with outside and inside handles.

.4 Larger Sizes: Provide an additional hinge.

.3 Access doors with sheet metal screw fasteners are not acceptable.

2.5 DUCT TEST HOLES

.1 **Temporary Test Holes:** Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

.2 **Permanent Test Holes:** Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.6 FIRE DAMPERS

.1 Fabricate to NFPA 90A, and as indicated.

.2 **Ceiling Dampers:** Galvanized steel, 0.76 mm (22 ga) frame and 1.5 mm (16 gauge) flap, two layers 3.2 mm (0.125 inch) ceramic fibre on top side and one layer on bottom side for round flaps, with locking clip.

.3 **Horizontal Dampers:** Galvanized steel, 0.76 mm (22 ga) frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

.4 **Curtain Type Dampers:** Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations closure under air flow conditions. Configure with blades out of air stream except for 250 Pa (1.0 inch) pressure class ducts up to 300 mm (12 inches) in height.

.5 **Multiple Blade Dampers:** 1.5 mm (16 ga) galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 3.2 x 12.7 mm (1/8 x 1/2 inch) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

.6 **Fusible Links:** UL 33, separate at 71 degrees C (160 degrees F) with adjustable link straps for combination fire/balancing dampers.

2.7 FLEXIBLE DUCT CONNECTIONS

.1 Fabricate to SMACNA 1966, and as indicated.

.2 **Connector:** Fabric crimped into metal edging strip.

.1 Fabric: UL listed fire-retardant neoprene coated woven glass fibre fabric to NFPA 90A, minimum density 1.0 kg/sq. m (30 oz./sq. yd.).

.2 Net Fabric Width: Approximately 50 mm (2 inches) wide.

.3 Metal: 75 mm (3 inch) wide, galvanized steel 0.6 mm thick (24 gauge).

2.8 SMOKE DAMPERS

.1 Fabricate to UL 555S, and as indicated.

.2 **Dampers:** UL Class 1, multiple blade type fire damper, normally closed automatically operated by electric actuator.

.3 **Electro Thermal Link:** Fusible link melting at 74 degrees C (165 degrees F); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.9 VOLUME CONTROL DAMPERS

.1 Fabricate to SMACNA 1966, and as indicated.

.2 **Splitter Dampers:**

.1 Material: Same gauge as duct to 600 mm (24 inches) size in either direction, and two gauges heavier for sizes over 600 mm (24 inches).

.2 Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.

.3 Operator: Minimum 6 mm (1/4 inch) diameter rod in self aligning, universal joint action, flanged bushing with set screw.

.3 **Multi-Blade Damper:** Fabricate of opposed blade pattern with maximum blade sizes 200 x 1825 mm (8 x 72 inch). Assemble centre and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

.4 **End Bearings:** Except in round duct work 300 mm (12 inches) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

.5 **Quadrants:**

.1 Provide locking, indicating quadrant regulators on single and multi-blade dampers.

.2 On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

.3 Where rod lengths exceed 750 mm (30 inches) provide regulator at both ends.

2.10 **MOTORIZED CONTROL DAMPERS - DESIGNATED MD-1, ETC.**

.1 Motorized Control Dampers shall be Tamco Series 9000.

.1 Damper frame construction shall be 4 deep, .080" thick extruded aluminum insulated with rigid Styrofoam on four sides and flanged for flange mount to duct.

.2 Blades shall be extruded aluminum (6063T5) insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29.

.3 Blade gaskets shall be extruded EPDM. Frame seals shall be of extruded TPE.

.4 Blade bearings are to be composed of a Celcon inner bearing fixed to a 7/16" aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame.

.5 Linkage hardware shall be installed in the frame side and be constructed of aluminum and corrosion resistant, zinc plated steel, complete with cup-point trunnion screws for slip-proof grip.

.6 Minimum leakage on a 48" x 48" damper at 4" W.G. shall be less then 4.12 CFM per sq. ft. Damper shall meet AMCA Standard 500 performance criteria.

.7 Pressure drop of a fully open 48" x 48" damper shall not exceed .03" w.g. at 1000 FPM.

.8 Dampers shall be available in opposed blade or parallel blade action.

.9 Dampers shall be parallel blade action for two position operation and opposed blade action for modulating face and bypass operation, and sized to suit opening they will be installed in without blanking off free area.

.2 Acceptable Products:

.1 Tamco

.2 Nailor

.3 Ruskin

.4 NCA

.3 Refer to Schedule on Drawings for damper sizes.

2.11 **ACOUSTIC DUCT LINER**

.1 Insulation to be flexible, edge coated, tightly bonded, mat-faced and shall be made from inorganic glass fibres bonded by a thermosetting resin.

.2 Insulation shall be 1" (25 mm) thick, 1.4 lb/ft^3 (22 kg/m^3) density, where designated on the drawings by diagonal hatching or where noted.

.3 Liner shall be treated so that the maximum flame spread rating is 25 or less and the smoke development is 50 or less according to local bylaws.

2.12 **ROUND SPIN-IN DUCT COLLARS**

.1 Spin-In Collar: Take-off connection from rectangular duct to round or flexible duct for air diffusers, troffers etc.

.1 Flexmaster Model 1801 (without damper) or equivalent

.2 Flexmaster Model 1802 (with damper) or equivalent

2.13 **DUCT SEALING**

.1 All duct joints during manufacture shall be sealed with high velocity sealer, equal to Baker Duck-Seal, or Duro Dyne DWN high velocity sealer, and on the faces of the joints after cleats are installed.

.2 DUCT TAPE IS NOT ACCEPTABLE.

2.14 **LOUVRES - DESIGNATED WL -1, -2 ETC.**

.1 Louvres to be factory constructed of the size listed in the Louvre Schedule.

.2 Frames to suit building construction. Louvres are to be extruded aluminum.

.3 All louvres to be free of scratches and be finished in Kynar 500 coating.

.4 Louvres to have flanged face and be complete with weep holes for self draining.

.5 Provide birdscreens on all louvres.

.6 Acceptable Products:

.1 E. H. Price

.2 Construction Specialties

.3 Penn

2.15 **VRF FAN COIL MIXING BOX PLENUMS**

.1 Supply and install mixing box plenums at the suction side of each piece of equipment. Plenum to match unit size and be open at the back to allow recirculation air into the unit. Plenum depth to be minimum 400 mm.

2.16 **FILTER GAUGES**

.1 Supply and install across filter section of each indoor supply air unit, a Dwyer Minihelic II air filter gauge.

2.17 **FAN SHEAVES**

.1 Supply as requested by the Balancing Agency, replacement sheaves and fan belts for each supply, return, and exhaust fan blower as required during the system air balancing.

.2 Replacement of sheaves and belts shall be by Division 23 as requested by the Balancing Agency and Consultant.

Part 3 - Execution

3.1 **PREPARATION**

.1 Verify that electric power is available and of the correct characteristics.

3.2 **INSTALLATION**

.1 Install accessories to manufacturer's written instructions, NFPA 90A. Refer to Section 23 31 00 for duct construction and pressure class.

.2 Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

.3 Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust duct work to NFPA 96. Provide minimum 200 x 200 mm (8 x 8 inch) size for hand access, 450 x 450 mm (18 x 18 inch) size for shoulder access, and as indicated. Provide 100 x 100 mm (4 x 4 inch) for balancing dampers only. Review locations prior to fabrication.

.4 Provide duct test holes where indicated and required for testing and balancing purposes.

.5 Provide fire dampers combination fire and smoke dampers smoke dampers at locations indicated, where ducts and outlets pass through fire rated components and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.6 Install smoke dampers and combination smoke and fire dampers to NFPA 92.

.7 Demonstrate re-setting of fire dampers to Owner Representative.

.8 Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment [and supported by vibration isolators. Refer to Section 23 05 48. for fans developing static pressures of 1250 Pa (5.0 inches) and over, cover connections with leaded vinyl sheet, held in place with metal straps

.9 Use splitter dampers only where indicated.

.10 Provide balancing dampers on high velocity systems where indicated. Refer to Section 23 36 00.

.11 Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

3.3 BALANCING DAMPERS

.1 Splitter or opposed blade dampers for adjustment of air distribution to respective branches to be located as indicated on Drawings, or as described in other parts of this Specification.

3.4 DUCTS AT MASONRY

.1 Where ducts are shown connecting to or terminating at masonry openings, and/or along the edges of all plenums at floors, walls, ceilings, etc. Provide a continuous 1-1/2" x 1-1/2" x 1/8" (38 mm x 38 mm x 3 mm) galvanized angle iron bolted to the construction and made air tight to same by applying approved caulking compound on the angle before they are drawn down tight. The sheet metal at these locations to be bolted to the continuous angle iron.

3.5 LOCATION OF OUTLETS

.1 The position of all outlets shown on the Drawings are approximate only and this Contractor is to check the location of all outlets with the Consultant and make such adjustments in position as are necessary to conform with architectural features, acoustic tile pattern, etc. and the outlets required by other trades without extra charge. Ceiling outlets and their assemblies to be constructed so that they fit the spacing and manufacture of the removable acoustic ceiling.

3.6 **OUTSIDE OPENINGS**

.1 Unless specifically noted otherwise, openings in the outside walls, roof, etc. to be left for this Contractor, where shown and required for fresh air intakes and exhausts.

.2 Louvres, birdscreens, etc. for these intakes and exhausts, to be supplied by other trades and installed by this Division. Supply and install all necessary ductwork and plenums for intakes and exhausts and patch around same to make a weather tight job. Co-operate with all other trades on exact location of these openings, ducts, and louvres, serving the air systems. Supply and install 14 ga. insulated louvre blank-offs where shown for blanking off unused portion of louvres.

3.7 **DUCT ACCESS DOORS**

.1 Install removable access doors to fire dampers or other dampers, humidifier manifolds, heating coils (both sides), main ducts for cleaning purposes, for service, inspection, any other normal maintenance requirements, and for cleanouts where required on specialty systems. Ensure that such access doors are of a size that equipment to be attended is accessible.

.2 Access doors are to be fully accessible.

3.8 **TURNING VANES**

.1 Install small arc air foil vanes in ducts at elbows where centre-line radius is less than 1-1/4 times turning dimension of duct.

.2 Square elbows with turning vanes equal to Hart and Cooley double thickness vanes spaced at 1-1/2" (40 mm) centres up to 24" (600 mm) duct and 3" (75 mm) centres over 24" (610 mm). Rovane duct turning vanes are acceptable.

3.9 **WATERTIGHT DUCT**

.1 Provide watertight ductwork for:

.1 Fresh air intakes.

.2 Exhaust air outlets.

.2 Form bottom of duct without longitudinal seams. Solder or weld joints of bottom sheets and sides. Solder or weld transverse joints and caulk.

.3 Slope duct back to exterior louvre outlet and Provide weep holes for drainage.

3.10 **SUPPLY, RETURN & EXHAUST FANS**

.1 All connections to fans to be made utilizing canvas connections as specified under this Section.

.2 All fan systems are to be equipped with all accessories indicated in schedule.

.3 Refer to Division 25 Controls and Instrumentation and Division 26 Wiring Connections, and co-ordinate Work.

3.11 **CURBS**

.1 All new prefabricated roof curbs supplied by this Division. All curbs flashed by Roofing Contractor. Refer to details on Drawings.

3.12 **ACOUSTIC DUCT LINER**

.1 Install acoustic duct liner in all ducts shown diagonally-hatched, or otherwise specified with duct liner.

.2 Apply adhesive to the interior of the duct and supplement the adhesive with welding pins and clips, the pins shall be spaced no further than 12" apart, no more than 4" in from a corner or edge of the duct. Duct 8" wide and smaller does not require adhesive supplement.

.3 Trim all pieces of liner such that all corners and joints fit tight, without bulges.

.4 Apply liner adhesive to all joints, seams, and exposed edges, including all traverse joints as the duct is assembled.

.5 At the upstream leading edge of exposed liner, Provide a step collar or insulation stop to cover the entire edge of the exposed liner.

.6 Interrupt the duct liner installation at fire dampers.

.7 Where dampers (motorized or manual), turning vane, or other interior duct device is to be mounted, Provide a metal hat section or other build out to secure the damper or device. Fire dampers may not be mounted to a hat section, oversize fire dampers to the outside duct dimensions or Provide step collars on either side of the fire damper.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Sidewall Direct Drive Fan

.2 In-line Cabinet Fan

.3 Belt-Drive Centrifugal In-line Fan

.4 Circulating Fans

.5 Vehicle Exhaust Extraction System

.6 Fan Accessories.

1.2 RELATED SECTIONS

.1 Section 23 05 48 - Vibration Isolation.

.2 Section 23 07 13 - Duct Insulation.

.3 Section 23 31 00 - Duct Work.

.4 Section 23 33 00 - Duct Work Accessories: Backdraft dampers.

.5 Section 23 73 23 - Air Handling Units.

.6 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

.4 ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

.5 AMCA 99 - Standards Handbook.

.6 AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.7 AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

.8 AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.9 SMACNA 1966-2005 - HVAC Duct Construction Standards - Metal and Flexible.

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

.3 Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Manufacturer's special installation requirements.

1.6 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Maintenance Data : Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials: Provide two (2) sets of belts for each fan.

1.8 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Protect motors, shafts, and bearings from weather and construction dust.

1.9 **ENVIRONMENTAL REQUIREMENTS**

.1 Site Conditions: Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

Part 2 - Products

2.1 **GENERAL**

.1 Acceptable Manufacturer: Greenheck.

.2 Acceptable Alternates: Twin City, Accurex.

.3 Supply and install the following exhaust and recirculating fans of the size, type, model and type as specified below and contained in the Fan Schedule. Accessories listed in the specifications apply to all fans of the same type. Special accessories for individual fans are designated on the Fan Schedule.

.4 Sound level performance and fan curves shall be included with submittal drawings.

.5 Suspend fans from structure through vibration isolators and connect to ductwork through flexible duct connections. Mount fan in place with backdraft dampers and gasket seals.

.6 Power wiring for fans is by Division 26.

.7 Control wiring is by Division 25.

2.2 **SIDEWALL DIRECT DRIVE FAN - DESIGNATED EF-1, 2:**

.1 Manufacturer: Greenheck.

.2 Fan panels of galvanized steel. Aluminum blade propeller. Die formed, galvanized steel drive frame assembly. Corrosion resistant fasteners.

.3 Motor with CSA Approval. UL/cUL 705 Listed - "Power Ventilators"

.4 Short Wall Housing, Flush Exterior, w/OSHA Grd., Factory Installed. Galvanized steel construction, heavy gauge mounting flanges, pre-punched mounting holes, inside flanges allow damper to be mounted. Overlapping weather hood flange keeps rain out. OSHA Protective guard of welded steel wire completely protects the drive side of the wall housing.

.5 Motor Access from Int. of Bldg.

.6 NEMA-1 Toggle switch. Enclosure constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection against falling dust. This enclosure meets the rod entry and the indoor corrosion protection design tests. The rod entry test is intended to simulate incidental contact with enclosure equipment. Enclosure is equipped with provision to lockout in the off position with customer supplied lock.

.7 Junction Box Mounted & Wired

.8 Weather hood, Galvanized 45 deg. with Bird Screen, field installed by installing contractor

.9 Damper Mounted, WD-320-PB-22X22, Gravity Operated, Not Coated. Model WD-320 is a vertical mount exhaust damper and is constructed of 18 ga galvanized steel with pre-punched mounting holes and a flanged frame - Damper blades are 0.025 in. roll formed aluminum with vinyl seals on the closing edge - Steel axles are 0.188 in. diameter zinc plated mounted steel in nylon bushings - Synthetic axle bearings.

.10 ESD-435 weather louver designed to protect air intake and exhaust openings in building exterior walls. Design incorporates drain gutters in the head member and horizontal blades to channel water to the jambs where water is further channeled through vertical downspouts and out at the sloped sill. 4 in. Frame, 35 deg blade. Mill finish c/w aluminum birdscreen.

.11 The VCD-23 ruggedly built low leakage control damper intended for applications in low to medium pressure and velocity systems. C/W electric actuator. 16 GA thickness, galvanized, opposed blade action, TPE blade seal. 24 VDC actuator, two position, spring return, failed open.

.12 EF-2 Motor starter Advanced Control:

.1 Model: MSAC-1-9/J-G1.1-40. NEMA and IEC, dual-rated contactor - HOA keypad - Hand, off, auto, run and fault lights - Conduit plate knockouts - Solid-state, electronic overload - Stall protection - Locked rotor trip - Max start time monitoring - Overload out of calibration protection -Adjustable power failure restart mode - 3 inputs for remote control; 12-250V direct voltage input, N.O. dry contact.

.2 and fireman's override - 2 output relays; motor status and fault alarm - Damper actuator control, 24 VDC, 30 VA max - Damper

.3 limit switch input - UL, Cul.

2.3 IN-LINE CABINET FANS - DESIGNATED EF-3

.1 Manufacturer: Greenheck.

.2 Corrosion resistant galvanized steel scroll and housing. Sound absorbing insulation. Rectangular inlet and outlet duct collar. Outlet with integral spring. Loaded back draft damper. Double inlet forward curved wheel. Plug type disconnect. Adjustable mounting brackets. Field rotatable discharge

.3 Motor rated for continuous use, with Thermal Overload with CSA Approval. Motor with 40 Degree C Ambient Temperature. UL/cUL 507 Listed

.4 Solid State Speed Control, 6 Amp. Field installed by installing contractor.

.5 Isolation Kit, (PN: VI KIT-SP/CSP), Field installed by installing contractor. Kit includes four isolators and all hardware necessary for mounting one unit except for the 0.25 in. x 20 in. Fan mounting brackets include prepunched mounting holes for ease of installation

.6 Energy Star Certified

.7 Polypropylene Wheel Material

.8 Louver - Mill Aluminum Finish

.9 The VCD-23 ruggedly built low leakage control damper intended for applications in low to medium pressure and velocity systems. C/W electric actuator. 16 GA thickness, galvanized, opposed blade action, TPE blade seal. 24 VDC actuator, two position, spring return, failed open.

.10 22-2FER-2 actuator driven damper. Belimo FSNF24-S-FC actuator

2.4 **CIRCULATING FANS - DESIGNATED HVLS-1, 2 ETC**

.1 Acceptable Manufacturer: Greenheck

.2 Acceptable alternates:

.1 Titan

.2 Patterson

.3 **General Description:**

.1 High Volume, Low Speed (HVLS) overhead fans shall be licensed to bear the AMCA Certified Rating Seal for Circulating Fan Performance to ensure performance as cataloged in the field. Unlicensed overhead fans shall not be accepted.

.2 Entire fan assembly (with or without the optional LED light kit) shall be UL/cUL-Listed to Underwriters Laboratory (UL) Standard 507 and CSA Standard 22.2 No. 113 to ensure compliance with the most current international testing standards. Intertek/ETL certification to UL Standard 507 and CSA Standard 22.2 No. 113 shall not be accepted.

.3 Fans are available in four sizes with nominal impeller diameters ranging from 8 feet through 14 feet.

.4 Performance capabilities up to 55,800 cubic feet per minute (cfm).

.5 Maximum continuous operating temperature of 104° Fahrenheit (40° Celsius).

.6 Designed for forward (counter-clockwise when viewed from floor) and reverse (clockwise when viewed from floor) operation capabilities, for comfort cooling and destratification applications.

.7 Each fan shall bear a permanently affixed manufacturer's mylar nameplate containing the model number, individual serial number, and electrical requirements of the fan.

.4 **Impeller:**

.1 Impeller shall be constructed of aerodynamic 6005A-T6 extruded aluminum airfoil blades connected to a single-piece, laser-cut 5/16 inch steel hub for structural strength. Multi-piece hubs shall not be permitted. All connections shall be made using a minimum of SAE Grade 5 hardware.

.2 Airfoil blades shall be interlocked with one another and the impeller hub via a heavy-duty steel airfoil retaining ring for safety. Airfoil retaining ring shall be constructed of heavy gauge steel and installed at the factory to ensure proper function. Field-installed airfoil retainers shall not be accepted.

.3 Airfoil blades shall be provided with a mill aluminum finish as standard. Optional finishes shall include industrial powder coatings, anodize finishes, wood grain finishes, or custom color matched coatings.

.4 Airfoil blades shall be optimized for maximum airflow, fan efficiency, and coverage area.

.5 Airfoil blades shall be internally reinforced to minimize blade deflection while the fan is in standby or in operation. Blade deflection shall not exceed ±2.4 inches in either situation.

.6 Airfoil blades shall be designed for minimal weight in order to maximize fan efficiency. Individual blade weight shall not exceed 10 pounds.

.7 Impeller hub shall be secured to the face of the motor by a minimum of 6 bolts. Impeller hub shall also be connected to the building structure via a safety restraint cable and hub retaining ring. Hub retaining ring shall be constructed of heavy gauge steel and installed at the factory to ensure proper function.

.5 **Motor:**

.1 Ingress Protection 54 (IP54) - International Electrotechnical Commission (IEC) rating. IP54 rating denotes that motor is dust protected (limited ingress of dust permitted but will not interfere with operation of the equipment) and protected against water splashed from all directions (limited ingress permitted).

.2 Motors shall be of the high torque, low speed direct drive type, carefully matched to the fan load and furnished at the specified voltage and phase. High speed motors provided with a gearbox to reduce the operating speed of the fan shall not be permitted.

.3 Motors shall be an external rotor design. Internal rotor motors shall not be permitted.

.4 Motors shall be of the brushless DC type for maximum efficiency and speed controllability. No other motor type shall be accepted.

.5 Motors shall include plug-and-play connectors for all wiring to the variable frequency drive. Motors that require these wiring connections to be stripped and terminated in the field shall not be permitted.

.6 Motors shall include an internally-mounted thermistor for continuous monitoring of the motor's internal temperature.

.7 Motors shall include Class B insulation.

.6 **Variable Frequency Drive (VFD):**

.1 Ingress Protection 50 (IP50) - International Electrotechnical Commission (IEC) rating. IP50 rating denotes that VFD is dust protected (limited ingress of dust permitted, but will not interfere with operation of the equipment) and protected against vertically falling drops of water (limited ingress permitted).

.2 VFD shall be factory programmed and designed for Modbus RS-485 communication with control devices via the Modbus RTU communication protocol.

.3 VFD shall be UL Listed for single phase input at the specified voltage.

.4 VFD shall be provided with factory-installed, plug-and-play wiring for ease of installation. Plug-and-play wiring shall include power, communication, and fire alarm wiring pigtails that are designed for quick and easy termination in the field.

.5 VFD shall be factory-wired for power and control of LED light when fan is supplied with optional LED light kit.

.6 VFD shall include two thermistors for continuous monitoring of VFD's internal and external temperature.

.7 VFD shall include sensors for continuous monitoring of voltage and current.

.8 VFD shall include intelligent protection systems to prevent failures caused by over/under-voltage, over-current, over-temperature, over-speed, and fan impact. VFDs without these protection features shall not be permitted.

.9 VFD shall include the most current firmware version as of the product's manufacturing date to ensure optimal performance. As a result of continuous development, the manufacturer reserves the right to update VFD firmware without notice.

.7 **Universal Ceiling Mount & Downtube:**

.1 Fans shall be provided with a universal ceiling mount that is designed for fast and secure installation on a variety of building structures. Universal ceiling mount shall be constructed of heavy gauge, bolted steel and shall include a pivoting knuckle joint with one axis of rotation to accommodate any ceiling pitch.

.2 Downtube shall be constructed of heavy gauge steel to provide a structural connection between the universal ceiling mount and fan motor. Downtube shall also include a welded guy wire connection ring for fast and secure installation of guy wires when required based on downtube length.

.3 Universal ceiling mount and downtube shall be powder-coated for corrosion resistance and aesthetic appearance.

.4 Standard drop length between top of universal ceiling mount and top of airfoil blades shall be 2 feet. Optional drop lengths are also available in one foot increments between 3 and 10 feet.

.5 All hardware shall be a minimum of SAE Grade 5.

.8 **Safety Retention Cables:**

.1 Fans shall include a braided galvanized steel safety retention cable that is rated for a load of 495 pounds or greater. Safety retention cable shall be installed on the fan motor at the factory to ensure proper function. Field construction or installation of safety retention cables shall not be permitted.

.2 Safety retention cable shall be secured around the building structure via a minimum of two u-bolt steel cable clamps as standard. Optionally, safety retention cable may be secured via one No. 4 Gripple® connector for ease of installation.

.9 **Guy Wires:**

.1 Guy wires shall be included for fans with drop lengths equal to or greater than 4 feet in length. Guy wires shall be constructed of braided galvanized steel and designed to prevent lateral movement of the fan when installed.

.2 If included, guy wires shall be secured to the building structure via the supplied beam clamps and quick links for ease of installation.

.3 If included, guy wires shall be secured to the fan and tensioned via high-strength steel turnbuckles with quick links. Turnbuckles shall be connected to each guy wire via a minimum of two u-bolt steel cable clamps per guy wire as standard. Optionally, guy wires may be secured to the fan and tensioned via one UG2 Gripple® turnbuckle per guy wire for ease of installation.

.10 **Fire Control Panel Integration:** Fans shall include a normally closed electromechanical relay for integration with a building's fire control panel. Normally closed electromechanical relay shall be compatible with 24 VDC/VAC and 115 VAC control signals.

.11 **Options/Accessories:**

.1 Type: Hi-Pro Polyester

.1 Fan Components: Universal Ceiling Mount, Downtube, Impeller Hub, Winglets

.2 Colors: Flat Black

.2 Mounting Hardware (Refer to structural and architectural drawings):

.1 I-Beam Kit – Includes hardware for mounting fan to I-beams with a flange width up to 7.4 inches and a web thickness up to 0.75 inches.

.2 Steel Truss Kit – Includes hardware for mounting fan to structural steel angles (by others) that are sized to fit within steel trusses/bar joists.

.3 Unistrut® Kit – Includes universal ceiling mount that is designed for mounting fan to Unistrut® channels (by others) using Unistrut® hardware

.4 Wood Beam Kit – Includes hardware for mounting fan to wood beams 6 inches wide or greater.

.5 Z-Purlin Kit – Includes hardware for mounting fan to structural steel angles that are sized to fit within Z-purlins.

.3 Disconnect Switches:

.1 NEMA Rated: 1

.2 Protection: Fused

.3 Positive electrical shut-off.

.4 Shipped loose for field mounting.

.4 Overhead Fan Controls:

.1 Advanced Touchscreen Control with BACnet – Touchscreen control with LCD display. Allows users to operate up to 10 or 20 fans (as specified) individually or in groups, with any combination of fan models and sizes. Fans can be controlled locally via the touchscreen or remotely via the BACnet MS/TP communication protocol. Powered through 115V power adapter.

.2 Type: Advanced Touchscreen Control with BACnet

.3 Controls shall be capable of operating one or multiple overhead fans as specified. Controls shall provide start/stop, speed, and rotation direction control capabilities as well as diagnostic and fault history information for each connected fan. Controls shall also be capable of dimming the optional fan-mounted LED light.

.4 Controls shall include RJ45 ports for plug-and-play connection to overhead fans via shielded CAT-5e communication cable in the field.

.5 CAT-5e Cable Length: Factory-Assembled Cable Type: 100 feet: Factory-assembled CAT-5e cable must be shielded 26 gauge cable with a drain wire and must be compliant with ISO 11801 to prevent network communication issues. Cable must be provided in pre-determined lengths (as specified) and terminated with shielded RJ45 connectors with a soldered drain by the factory. Wiring configuration must follow EIA/TIA T568B wiring pinout and individual cable lengths must not exceed 200 feet.

2.5 **BELT-DRIVE CENTRIFUGAL IN-LINE FAN - DESIGNATED SF-1**

.1 Manufacturer: Greenheck model SQ.

.2 Galvanized steel housing. Backward inclined aluminum wheel. Two bolted access panels. Integral duct connection flanges. Ball bearing motors. Adjustable motor pulley. Adjustable motor plate. Fan shaft mounted in ball bearing pillow blocks. Static free belts. Corrosion resistant fasteners

.3 Motor with CSA Approval. UL/cUL 705 Listed - "Power Ventilators"

.4 NEMA-1, Toggle switch. Enclosure constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection against falling dust. This enclosure meets the rod entry and the indoor corrosion protection design tests. The rod entry test is intended to simulate incidental contact with enclosure equipment. Enclosure is equipped with provision to lockout in the off position with customer supplied lock.

.5 Insulated Housing - 1 in. Thick: Fan Housing, Filter Box, Motor Cover

.6 Sloped Filter Box, 2 in. Pleated (MERV 8) Filters

.7 Fan: Spring, Hanging, 1 Inch Isolator PN: 850343, Incl. 4 isolators and 4 brackets. The spring hanging isolator is designed to reduce the transmission of vibration and noise produced by suspended equipment and piping. To assure stability, the spring element has a minimum lateral stiffness of 1.0 times the rated vertical stiffness. The hanger will allow a support rod misalignment through a 30 degree arc and the isolation brackets will carry a 500% overload without failure. The isolator has an epoxy powder coated bracket and spring coil which is color coded according to the load capacity and has a noise isolation pad, all which is assembled into a stamped or welded hanger bracket.

.8 Filter Box: Spring, Hanging, 1 Inch Isolator PN: 850343, Incl. 4 isolators and 4 brackets. The spring hanging isolator is designed to reduce the transmission of vibration and noise produced by suspended equipment and piping. To assure stability, the spring element has a minimum lateral stiffness of 1.0 times the rated vertical stiffness. The hanger will allow a support rod misalignment through a 30 degree arc and the isolation brackets will carry a 500% overload without failure. The isolator has an epoxy powder coated bracket and spring coil which is color coded according to the load capacity and has a noise isolation pad, all which is assembled into a stamped or welded hanger bracket.

.9 ESD-435 weather louver designed to protect air intake and exhaust openings in building exterior walls. Design incorporates drain gutters in the head member and horizontal blades to channel water to the jambs where water is further channeled through vertical downspouts and out at the sloped sill. 4 in. Frame, 35 deg blade. Mill finish c/w aluminum birdscreen.

.10 The VCD-23 ruggedly built low leakage control damper intended for applications in low to medium pressure and velocity systems. C/W electric actuator. 16 GA thickness, galvanized, opposed blade action, TPE blade seal. 24 VDC actuator, two position, spring return, failed open.

.11 22-2FER-2 actuator driven damper. Belimo FSNF24-S-FC actuator.

.12 Price electric duct heater. DF CI00H. STS3-13C thermostat.

2.6 VEHICLE EXHAUST EXTRACTION SYSTEM

.1 This supply and install of this product is to be included as a cash allowance. Refer to architectural division for further information.

.2 Summary

.1 The successful vendor shall Provide all labor, materials, and equipment necessary to put in working operation a complete turnkey vehicle exhaust removal system to remove both diesel and automotive exhaust gases and particulate of operating vehicles within the confines of specified fire station(s). All necessary controls, motors, fittings, ductwork, blower(s), labor and all other equipment and materials specified shall be part of the work.

.2 Section Includes:

.1 Manufacturer

.2 Rail Material

.3 Top Mounting Suspension
.4 Support Legs
.5 Hydraulic Brake System
.6 Rail Splicing Joint
.7 Middle Rail Duct Connection
.8 Trolley Assembly
.9 Upper Flexible Hose
.10 Mid Hose
.11 Lower Hose Assembly
.12 Safety Disconnect Coupling Handle
.13 Collection Nozzle Assembly
.14 Hose Saddle
.15 Electrical Controllers
.16 Electrical System
.17 Air Moving Devices
.18 Ductwork System

.3 All items of equipment and materials described in these specifications are to be furnished installed and placed into proper operating condition in accordance with good practice and manufacturer's written or published instructions.

.1 The vehicle exhaust removal system shall provide virtually 100 percent complete evacuation of all diesel fumes at the source from start up to exit of the apparatus from the fire station. The vehicle exhaust removal system shall be capable of delivering complete coverage for bays up to 60 ft. (18.3 m) in length. The system must be able to accommodate drive through and back-in bays to meet all the needs of the fire department.

.2 System must be designed and installed to NIOSH recommendation, specifying that occupational exposures to carcinogens be limited to the lowest feasible concentration. Exposure in the human breathing zone should be limited to lowest feasible level, without any time delay required for the system to effectively capture the diesel fumes.

.3 System must also be capable to provide virtually complete capture and evacuation of carbon monoxide emitted as part of the vehicle exhaust.

.4 Systems that solely use filters, in which diesel particulate may accumulate, and that would potentially have to be treated as hazardous materials, will not be accepted.

.5 System must meet the guidelines for the International Mechanical code for Source Capture Systems. Such system is defined as a mechanical exhaust system designed and constructed to capture air contaminants at their source and to exhaust such contaminants to the outdoor atmosphere.

.6 The system shall not affect personnel boarding the apparatus. Hose loops shall not hang any lower than six feet (1.8 m) from the bay floor. The hose assembly shall not come into contact with the vehicle other than one connection point to the vehicle's tailpipe. The hose assembly shall not touch or drag on the bay floor.

.7 The exhaust system shall not block doorways, exits, and aisles in the apparatus bay, which could endanger the welfare of fire personnel or visitors.

.8 The exhaust system shall not need to be disconnected from the vehicle while shore lines are connected, during battery charging, or washing of the vehicle, as with other types of systems.

.9 To protect the apparatus electrical system from possible damage, the system bid shall not incorporate any type of electromagnetic device that requires the apparatus to be utilized as an electrical ground for systems operation.

.10 Due to the harmful effects of diesel exhaust, the system must be designed and capable of capturing virtually 100% of the exhaust gas and virtually 100% of the particulate even in the event of a complete power failure. The system shall not detach itself from the apparatus for any reason during a power failure other then normal exiting of the apparatus bay. System shall discharge exhaust outside the station even in the event of a power failure.

.11 The system shall capture the exhaust gases and particulate directly from the tailpipe of the apparatus by a direct connected "visible" high temperature rated hose. Particulates emitted from the apparatus are known to be heavier than air and therefore must be captured by a directly connected hose with a tight seal, as loose nozzles or air filters cannot capture these heavy particulates. The particulates have been documented to be the main respirable carcinogen in diesel exhaust, and therefore are the primary concern of the fire department to capture virtually 100% of these particulates.

.3 **Rail Material:** One-piece continuous extruded aluminum rail in a minimum length of 19 ft. (5.8 m) in an effort to reduce the points of leakage due to joints or connections. The construction profile shall be of a square profile type, width of 5 ¾ inches (146 mm) with a rail thickness of 0.177 inch (4.5 mm). The bottom portion of the rail shall have a continuous slot to accept a rubber lip seal. Rail Material: Aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M). Aluminum Rail: Extruded as a one-piece design to maximize the structural integrity of the rail and to minimize joints. Extruded into the rail profile shall be all necessary mounting guides, which will allow for support of the rail mounting hardware. Mounting Channels: Provided continuously along the top on both sides of the rail extrusion in order the proper positioning of all required mounting supports in accordance with codes. The rail shall allow the trolley/hose assembly to glide to the door threshold in a safe and effective manner. The extruded rail channel shall allow the whole rail to remain rigid and shall provide an area to attach bolts for splicing additional rails together for systems over 19 ft. (5.8 m) long. The overall extruded rail lengths shall be 19 ft. (5.8 m) standard. Rail System: Equipped with a hydraulic braking system that limits travel of flex hose/trolley as the vehicle exits the building. Hydraulic Brake: Incorporated into the end cap of the suction rail.

.4 **Top Mounting Suspension**: Designed to attach with 2 mounting cleats to the mounting slots that are extruded into the top of the rail profile. The top suspension mount support shall consist of 2 triangular plates with a 90-degree brake providing a mounting cleat provided with 2 pre-punched 3/8 inch (10 mm) holes for attaching to the aluminum leg assembly.

.5 **Support Legs:** Support Leg and Mounting Feet: Manufactured and provided by the supplier of primary exhaust removal system (Equipment Manufacturer). Leg Material: Aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M). Supports shall come standard in 19 feet (5.8 m) lengths. A minimum of one support with appropriate bracing shall be provided for every 10 linear feet (3.0 m) of track profile. The support legs shall consist of a square tubular profile with dimensions no less than 2 inch (50.8 mm) OD X 0.1 inch (2.5 mm) with 3/8 inch (10 mm) fastening hardware provided. Vertical Adjustable Mounting Foot: Capable of attaching the leg assembly to a ceiling with a 30 degree pitch, complete with a slider bar and 3/8 inch (10 mm) hardware necessary for mounting the horizontal rail to the mounting channel system. Horizontal Adjustable Mounting Foot: Capable of attaching the leg assembly to a wall, complete with a slider bar and 3/8 inch (10 mm) hardware necessary for mounting the horizontal leg to the mounting channel system. Support Leg: Equipped with round tubular zinc-plated steel knee brace with pressed ends in standard lengths of 20 inches (508 mm), 30 inches (762 mm) and 72 inches (1.8 m). Angle completely adjustable to the leg support and mounted perpendicular and parallel to direction of the track. Typical Support Angle: 45 degrees from the centerline of the factory provided support leg. The standard leg shall be capable of meeting a Seismic 4 requirement. "Uni-strut", all-thread rod, and/or chains may not be used in place of a leg assembly as sole support of the system. Vertical support and bracing shall be provided to safely secure the rail profile in accordance with building code and seismic standards which may apply. A minimum of one support with appropriate bracing shall be provided for every 10 (3 m) to 12 linear feet (3.7 m) of rail profile.

.6 **Hydraulic Brake System:** Incorporated into the end cap of the suction rail profile. The hydraulic brake system must incorporate a hydraulic shock capable of reducing the forward impact of 1 to 2 suction trolleys which may be installed now or in the future to the exhaust rail system. This hydraulic shock shall be secured to a steel end cap fabricated of a 0.1181 inch (3 mm) steel plate with formed 90 degree side rails for rigidity. End cap shall be secured to the rail with 6- 8 mm bolts with Nyloc nuts (3 on each side). The end cap shall be of a black powder coated finish. The hydraulic shock shall be capable of reducing to a full stop the trolley(s) in less than 4 inch (102 mm), without physical damage to either the rail profile or trolley that it is stopping. The back end cap shall have an end feed 5 inch duct connection and shall be a black powder coated finish.

.7 **Rail Splicing Joint:** Formed steel fitting equal to the internal diameter of the suction rail profile. The splice shall have a wall thickness of no less than 14 gauge (2 mm) in thickness and a length of no less than 7.87 in. (200 mm) from end to end. Rail joint shall be secured by 12- 5/16 in. (DIN 933 M8) bolts with Nyloc nuts in the top and sides of the rail. Self tapping bolts or screws are not acceptable.

.8 **Middle Rail Duct Connection:** The rail duct connection shall be rectangular to a 5 inch (125 mm) diameter round transition fitting fabricated from 22 gauge (.8 mm) galvanized steel (ASTM A653/ 1.0330/DC01+ZE). The rectangular slot shall be 19.5 inches (498 mm) long by 1.8 inch (46 mm) wide with a 1/4 inch (6 mm) external flange to slide into the rail profile and secured with self-tapping screws.

.9 **Trolley Assembly:** Gantry type trolley with sealed bearing loaded wheels designed to roll inside the internal rail profile flange. The trolley chassis shall be aluminum and epoxy coated with a black finish. The chassis shall be fitted with a tapered suction cone. Rubber Sealing Lips: Vulcanized Teflon strip covering 1-1/2 inch (40 mm) of the bottom edge of the sealing lip which shall contact with (5) five Teflon rollers on each side of the suction cone to minimize resistance between the suction cone and the rubber sealing lips. The suction cone transition shall be a tapered slot design which shall fit inside the suction rail profile. The tapered slot shall be equal or exceed in area the diameter of exhaust ventilation hose to which it is attached. Trolley Assembly: Equipped with rubber impact bumpers at both the front and rear of the trolley chassis to eliminate metal to metal contact which could damage the trolley assembly. There shall be a system balancer assembly provided to aid in the delivery of the hose to the exit door. Balancer Assembly: Self-adjusting weight spring tension balancer with a lifting capacity of no less than 31 pounds (14 kg). The balancer shall have a minimum diameter steel cable of .080 inch (2 mm) and have a safety link connection.

.10 **Upper Flexible Hose:**

.1 Flexible ST (Standard Temperature) exhaust hose manufactured for the sole purpose of venting high temperature exhaust gases. Flexible Upper Hose: Designed strictly for the harsh environment of rapid response and auto-release of a vehicle exhaust tailpipe. Hose: Shall be 4-inch (100 mm) diameters with a length of 4 ft. (1.2 m), without joining or splicing connections. Hose Material: High temperature synthetic rubber impregnated into a high temperature laminated fabric with a mechanically crimped connection around a coated steel wire. This construction of hose must be capable of operating at continuous temperatures of 400 deg. F (204 deg. C) and intermittent temperatures of 500 deg. F (260 deg. C), such as are experienced when pump checks are performed inside the fire station. Protective Clip Cover: This shall be accomplished in a fashion, which eliminates any possibility of personnel coming in contact with an exposed hot metal helix and be provided in a safety yellow color. The bend radius of the high temperature hose shall be no less than 1.5 times the diameter of hose to ensure that hot gases are not restricted as they pass through the system. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard and/or shock hazard from being utilized as a grounded, grounding or current carrying conductor for electromagnet connections.

.2 Optional Flexible HT (High Temperature) Upper Hose: Flexible 4 inch (100 mm) or 5 inch (125 mm) diameter by 6 feet (1.8 m) long section of yellow and black hose identical in appearance to the mid and lower hose assembly and extending from the metal saddle to the crab hose connection. This construction of hose must be capable of transporting exhaust at continuous temperatures of 900 deg. F (482 deg. C) and intermittent temperatures of 1,050 deg. F (566 deg. C). An independent third-party test report shall be submitted with bid as proof of claim. Wire Helix: Bound and protected in laminations of high temperature material. This shall be accomplished in a fashion which eliminates any possibility of personnel coming in contact with an exposed hot metal wire helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. High Temperature Wear Strip: 9/16" inch (14.2 mm) wide and be provided in a safety yellow color. Hoses utilizing an exposed metal helix will not be acceptable due to potential personnel burn hazard.

.11 **Mid Hose:**

.1 ST (Standard Temperature) Mid Hose: Designed strictly for the harsh environment of rapid response and auto-release from a vehicle exhaust tailpipe. Semi rigid hose: Shall be 4-inch (100 mm) diameter by 10 ft. (3 m) long section of yellow and black hose identical in appearance to the lower hose assembly and extending from the metal saddle to the SDCH. Hose Material: High temperature synthetic rubber impregnated into a high temperature laminated fabric with a minimum overlapping thickness of 2-7/16" inches (62 mm). This construction of hose must be capable of operating at continuous temperatures of 400 deg. F (204 deg. C) and intermittent temperatures of 500 deg. F (260 deg. C), such as are experienced when pump checks are performed inside the fire station. An independent third-party test report shall be submitted with bid as proof of claim. Wire Helix: Bound and protected in laminations of hose winding. This shall be accomplished in a fashion which eliminates any possibility of personnel coming in contact with an exposed hot metal helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. Wear Strip: 9/16" inch (14.2 mm) wide and be provided in a safety yellow color. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard and/or shock hazard from being utilized as a grounded, grounding or current carrying conductor for electromagnet connections.

.2 Optional HT (High Temperature) Mid Hose: Designed strictly for the harsh environment of rapid response and auto-release from a vehicle exhaust tailpipe. Flexible hose: Shall be 4-inch (100 mm) or 5-inch (125 mm) diameter by 10 ft. (3 m) long section of yellow and black hose identical in appearance to the lower hose assembly and extending from the metal saddle to the SDCH. This construction of hose must be capable of transporting exhaust at continuous temperatures of 900 deg. F (482 deg. C) and intermittent temperatures of 1,050 deg. F (566 deg. C). An independent third-party test report shall be submitted with bid as proof of claim. Wire Helix: Bound and protected in laminations of high temperature material. This shall be accomplished in a fashion which eliminates any possibility of personnel coming in contact with an exposed hot metal wire helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. High Temperature Wear Strip: 9/16" inch (14.2 mm) wide and be provided in a safety yellow color. Hoses utilizing an exposed metal helix will not be acceptable due to potential personnel burn hazard.

.12 **Lower Hose Assembly**

.1 ST (Standard Temperature) Lower Hose: Rigid 4-inch (100 mm) or 5 inch (125 mm) diameter by 2 feet (610 mm) long section of yellow and black hose identical in appearance to the mid hose. This construction of hose must be capable of operating at continuous temperatures of 400 deg. F (204 deg. C) and intermittent temperatures of 500 deg. F (260 deg. C) such as are experienced when pump checks are performed inside the station. An independent third-party test report shall be submitted with bid as proof of claim. Supports the magnetic connection nozzle and stainless-steel reducing elbow in a rigid fashion to allow for the operator to place hose collection nozzle onto the tailpipe without bending over. The lower hose is the only section of hose which shall disconnect from the upper hose assembly and act as a safety disconnect in the unlikely event the nozzle gets entangled. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard.

.2 Optional HT (High Temperature) Lower Hose: Semi rigid 4" inch (100 mm) or 5" inch (125 mm) diameter by 2 ft. (610 mm) long section of yellow and black hose identical in appearance to the upper hose. This construction of hose must be capable of transporting exhaust at continuous temperatures of 900 deg. F (482 deg. C) and intermittent temperatures of 1,050 deg. F (566 deg. C). An independent third-party test report shall be submitted with bid as proof of claim. Wire Helix: Bound and protected in laminations of high temperature material. This shall be accomplished in a fashion which eliminates any possibility of personnel coming in contact with an exposed hot metal wire helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. High Temperature Wear Strip: 9/16" inch (14 mm) wide and be provided in a safety yellow color. Shall support the magnetic collection nozzle and stainless-steel reducing elbow in a semi rigid fashion to allow for the operator to place hose collection nozzle onto the tailpipe without bending over. The lower hose is the only section of hose which shall disconnect from the upper hose assembly and act as a safety disconnect in the unlikely event the nozzle gets entangled. Hoses utilizing an exposed metal helix will not be acceptable due to potential personnel burn hazard.

.13 **Safety Disconnect Coupling Handle:** Safety Disconnect Coupling Handle (SDCH): An injection molded composite body with a 4-inch (100 mm) or 5-inch (125 mm) diameter hose connection. A 360-degree rubber bumper to protect the vehicle and disconnect from wear shall be incorporated in the design of the system. Coupling: Consists of a aluminum inner flange collar connected by a patented easy reconnect mechanism. The release tension of this device shall be preset at 102 pounds of force (450N) and easily reconnected with only 3 pounds of force (13N).

.14 **Collection Nozzle Assembly:**

.1 Collection Nozzle Assembly: Provides a substantially airtight seal around exhaust tail pipe when connected thus allowing for virtually 100% source capture. The seal shall limit the escape of life-threatening exhaust gases.

.2 The Magnetic Nozzle shall be engineered and designed with rare earth magnets that are strategically positioned on the face of the collection nozzle. The Magnetic Nozzle shall be coated with a galvanized finish or the optional BlackArmour version high temperature, wear and corrosion resistant duplex coating, to limit the effects from corrosive road treatment chemicals. The collection nozzle shall also incorporate a protective rubber safety cover to avoid damage to vehicle and surroundings. The magnets shall only make contact with the face of the tailpipe adapter located on the tailpipe. The reducing elbow that connects the flexible hose to the collection nozzle shall be fabricated using continuous welded construction and shall be made from polished 304 stainless steel. The angle of transition shall be no less than or greater than 67 degrees from the centerline of the reducer. The stainless-steel reducer shall incorporate a primary expanded metal debris screen, which is permanently affixed by weld joints to the inside opening of collection nozzle. The collection nozzle shall be connected from a upright standing position by the user without bending over. Since this item is a point of safety for both personnel and the system itself.

.3 The standard conical tailpipe adapter shall be plated with a galvanized finish to limit corrosion from corrosive road treatment chemicals. The conical tailpipe adapter shall be of a self-aligning "Click and Seal" design for aiding in the connection and release of the collection nozzle from the fire apparatus.

.4 The optional TopGrade conical tailpipe (5") adapter shall be constructed from a high temperature, corrosion resistant, magnetic stainless steel, to limit the effects from extremely aggressive corrosive road treatment chemicals. The conical tailpipe adapter shall be of a self-aligning "Click and Seal" design for aiding in the connection and release of the collection nozzle from the fire apparatus.

.15 **Hose Saddle:** Metal Hose Suspension Saddle: Fabricated of steel and powder coated with a black matte finish specifically manufactured for the sole purpose of suspending high temperature exhaust ventilation hose in a rapid response and auto-release application. The design of the saddle shall smoothly transition the direction of the hose during its travel along the track. Securing clamps shall be provided including a link fastener, for the purpose of attaching it to the balancer.

.16 **Electrical Controllers:**

.1 Controller: Built and supplied by a UL and CUL recognized and listed exhaust system manufacturer. Controller shall carry the UL and CUL listing label as an "Enclosed Industrial Control Panel." Individual components listed by UL and CUL shall not satisfy the above requirement. Manufacturer shall undergo quarterly inspections by UL to verify all requirements and standards are met as outlined by UL and CUL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications to follow.

.2 Electrical Controllers: Bear a visible UL and CUL listing label as proof of subscribership and shall be validated by UL www.ul.com/database/ as an "Enclosed Industrial Control Panel". Certification documents shall accompany bid documents. Electrical controller and manufacturer shall be recognized and listed by UL and CUL. Controller shall be manufactured in accordance with Underwriters Laboratories standard UL-508A for "Enclosed Industrial Control Panels". The electrical controller shall include a Class 1 limited energy control circuit. Enclosures shall be NEMA 12 rated and UL listed as Type 12. The electrical control components shall be provided and mounted in an electrical enclosure to restrict access to internal components of the controller by authorized personnel only.

.3 Controller Performance: Designed to sense the output pressure and/or temperature change inside the ductwork system, which is normally generated by any internal combustion engine designed to propel a motor vehicle. The operating logic shall be designed to complete this cycle. At any point in time when a collection device is connected to a motor vehicle's exhaust tailpipe, as the operator starts the vehicle, the controller shall automatically sense the engine's output pressure or temperature of the exhaust and in turn energize the electrical contractor which will supply power to the AMCA certified spark resistant fan. Through the use of an adjustable timer the controller shall keep the contactor energized for up to sixty minutes in accordance with the station's response requirement. If the responding vehicle does not disconnect from the exhaust ventilation system in less than the designated setting, the optional temperature override switch shall override the time delay to ensure continuous system operation. This automated function will work for as long as the exhaust gas temperature is in excess of the setting on the heat sensor located in the ductwork system. This cycle shall not allow the electrical contractor, which energizes the exhaust fan, to short cycle or stop the fan while the system is connected to an operating vehicle.

.4 Motor Control Contactor: Allen Bradley Industrial Electrical Contactor 100C series. The contactor shall be UL - CUL listed as an approved component.

.5 Motor Control Overload Relay: Allen Bradley 193 E1 Plus series. Overload relay shall have an adjustable trip range to meet the proper full load amperage of the blower motor.

.6 Soft Touch Controls: Incorporated on the face or the access door of the controller by the use of an adhesive backed Lexan membrane type label to prevent water infiltration, which would void the NEMA 12 rating. Label: Provided and secured permanently to the exterior of the electrical controller. Label: Includes the name of the manufacturer, address, telephone number, user instructions and any warnings or cautions required by Underwriters Laboratories.

.1 Auto Start: This mode of operation shall be strictly for normal day to day use, as it would apply to receiving an emergency call and leaving the station. Any one or combination of the three devices listed below in Paragraph K shall activate the system. The system shall maintain itself in the Auto Start mode and always return there after the Stop sequence has been initiated. The controller shall not have a permanent off position due to the potential health hazards of diesel exhaust components.

.2 Stop: This mode of operation shall be a system override to shut down the system manually. Upon activating this mode of operation the exhaust system blower shall shut down. After a period not to exceed three seconds the controller shall automatically return to the Auto Start ready mode. This shall be a safety feature to prevent a potential health hazard from carcinogenic diesel exhaust leakage from systems having an undesirable open nozzle.

.3 Manual Run: This mode of operation shall be a system override to run the exhaust system blower continuously for the purpose of running the vehicles indoors for equipment checks during inclement weather. Upon activating this mode of operation, the exhaust system blower shall start and run continuously until the Stop mode is activated at which point the system will automatically return to the Auto Start ready mode within a maximum three second time period.

.7 System Indicator LED's: Show system status at all times.

.1 Auto Start Indicator: Indicate the system is in the fully automatic mode of operation and that power is on to the controller.

.2 Fan On Indicator: Indicate that power is being applied to the system blower and the controller is operating normally.

.3 Filter Status Indicator: Indicates, if flashing, excessive pressure loss across the optional filter bank media. Consequently, the filter must be serviced to maintain optimum efficiency of the system.

.4 Stop Indicator: Indicate the fan has been manually de-energized and will return to the Auto Start ready sequence in less than three seconds to prevent the system blower from being left in the Off mode.

.5 Manual Run Indicator: Indicate the fan is operating in a continuous run mode until interrupted by the stop mode activation.

.8 Controller Transformer: UL listed industrial control circuit transformer sized to properly supply all components so that only one transformer shall be required. Transformer shall be provided with multi-tap primary for 115, 208, 240, 277, 400, 480, and 600 VAC, and 24 VAC secondary operating on 50 or 60 hertz with a capacity of 35 volt amperes.

.9 Control Circuit Protection: By the use of primary and secondary fuses to meet UL and CUL requirements. The primary shall be protected by a pair of FLQ style fuses. A single GMA style glass fuse rated at 3.15 amps at 250V shall protect the secondary side of the control circuit.

.10 Electronic Control Circuit Card: Solid state printed circuit board. The soft touch controls shall be an integral part of the control circuit card. The control circuit card shall utilize a potentiometer to adjust the length of the timing cycle up to 60 minutes. It shall incorporate several different modes of operation and optional features.

.11 Activation Devices:

.1 Engine Start Switch: An engine pressure sensing type, capable of recognizing the output pressure of any type of motor vehicle exhaust. The electrical contact shall be dry type and not to exceed 24VAC. There shall be one sensor per vehicle.

.2 Optional Thermal Start Switch: Temperature sensing switch of the snap disc type and adjustable from 90 deg. F (32 deg. C) to 130 deg. F (55 deg. C) to configure the system based on different exhaust temperatures. There shall be one sensor per vehicle if chosen.

.3 Optional Wireless Transmitter and Receiver System: Shall be an optional feature operating on a 2400 MHz frequency. Complies with FCC rule part 15, FCC ID: UY124. The receiver shall utilize 3 independent channels of control and capable of supporting up to 60 transmitters. The receiver shall operate on 12-24 VAC or VDC and enclosed in a non-metallic enclosure with a clear see through lid to view system supervisory functions. The transmitter shall be programmable and shall be powered by a 3 year battery for ease of replacement and cost savings. The transmitter shall have an open field range of 1000 feet (305 m) and shall be initiated by a NO contact closure such as from a pressure switch mounted on the traveling exhaust system trolley or a vehicle powered ignition transmitter mounted in the vehicle.

.12 Clean Filter Indicator Alarm: Used in conjunction with an optional Unifilter for filtering diesel exhaust particulate before release to the atmosphere. The clean filter indicator shall monitor the pressure loss across the filter bank media. Once the useful life of the filter has been depleted the pressure differential switch will signal a high-pressure loss and flash the "Fan On" indicator while the exhaust blower is running.

.13 Optional System Monitor: Shall be an optional feature to monitor the system and advise when a preset number of emergencies runs or run time on the system have accrued.

.14 Optional No Airflow Alarm: Shall be an optional feature to monitor the system and advise when the exhaust fan is not functioning properly.

.15 Optional Carbon Monoxide Alarm: Shall be an optional feature to monitor the carbon monoxide levels inside the apparatus bay area.

.16 Electrical Wiring: Run in wire channel to allow for easier identification of the wiring circuits and for a neat appearance. All wiring circuitry shall meet National Electric Code and UL and CUL standards for proper size, bending radiuses and terminations.

.17 Electrical Terminal Block: 600 V, UL and CUL rated and recognized. It shall provide individual connection points for remote controls, clean filter indicator and power connections. The primary and secondary control wiring fuses shall be incorporated into the terminal block as one unit.

.18 Product Manual: Shall be provided with each electrical control box supplied. The product manual shall include a description of components with part numbers inclusive to the controller. It shall include a wiring schematic showing all internal circuitry as well as all field installed wiring connections to the controller.

.19 Electrical Interference: To protect the apparatus and communications, designs that allow any possibility of electrical back-feed or induced current which may interfere with a central services communication or onboard vehicle computer logic or navigational equipment will not be accepted.

.17 **Electrical System:**

.1 Station Electric Supply Panel: The power circuit for the "Emergency Response Vehicle Exhaust Removal System" shall originate in a circuit breaker panel board of the appropriate size to handle the load. Fan circuit shall be supplied by a UL listed, HACR rated circuit breaker (HACR rating is specifically for motor type loads) of the same type as indicated by the manufacturer of the circuit breaker panel or a dual element time delay fuse for fuse style panels. The circuit shall be clearly marked on an engraved ledger plate or in ink on the panel schedule as "Emergency Response Vehicle Exhaust Removal System".

.2 OS-3 Automatic Controller: Built and supplied by a UL recognized and listed exhaust system manufacturer. Controller shall carry the UL - CUL listing label as an "Enclosed Industrial Control Panel". Individual components listed by UL shall not satisfy the above requirement. Manufacturer must undergo quarterly inspections by UL to verify all requirements and standards are met as outlined by UL and CUL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications in 2.16 Electrical Controllers. The controller shall be mounted 6 feet (1.8 m) to the top of the cabinet AFF (above finished floor). A safety disconnecting means must be within sight of the controller for servicing and for safety reasons. If the supply panel is not within sight, a separate disconnecting means is required beside the controller (per NEC Code 2020). Safety disconnect shall be capable of being locked in the off position to follow lockout, tag out procedures.

.3 Power Wiring Conduit: Minimum of EMT utilizing fittings for damp locations such as apparatus wash down areas (per NEC Code 2020). Conduit shall be supported with a conduit strap every 10 ft. (3 m) and within 3 feet (1 m) of each box or termination, (per NEC Code 2020).

.4 Power Wiring from Supply Panel to OS-3: THHN stranded copper wire consisting of a flame retardant, heat-resistant thermoplastic insulation with a nylon jacket for abrasion, gas, and oil resistance and rated up to 600 volts or similar.

.5 Low Voltage Control Wiring: Minimum of a 16/2 multi-conductor cable to meet UL standards for the controller's low voltage field wiring.

.6 Low Voltage Control: Encased in a minimum of 1/2 inch (12.7 mm) EMT from the OS-3 Controller to the attic or building steel where it shall terminate with a EMT connector with a threaded plastic bushing. Conduit: Supported with a conduit strap every 10 feet (3 m) and within 3 feet (1 m) of each box or termination (per NEC Code 2020). The 16/2 multi-conductor cable shall be supported by the building structure and ran in a manner that the cable will not be damaged by normal building use (per NEC Code 2020), securely fastening it with nylon tie wraps every 24 inches (610 mm) to 36 inches (914 mm). Draping of the cable perpendicular to building steel or support members will be unacceptable.

.7 Power Wiring from OS-3 to Fan Motor: Minimum of EMT utilizing compression type fittings for damp locations such as apparatus wash down areas (per NEC Code 2020). Conduit shall be supported with a conduit strap every 10 ft. (3 m) and within 3 ft. (1 m) of each box or termination (per NEC Code 2020). Conduit shall extend through the outside wall through a hole of the proper size and terminate directly into the back of the safety disconnect with the appropriate connector and sealed with a silicon sealer or cement mortar. (Using fan model number select appropriate wire from Table 1-1).

.8 Fan Safety Disconnect: Non-fusible, NEMA 3R rated for wet locations, mounted adjacent to the AMCA Certified blower. Safety disconnect shall be capable of being locked in the off and on position to follow lockout, tag out procedures (per NEC Code 2020).

.9 Liquid Tight Flexible Metal Conduit: UL listed liquid tight flexible metallic conduit (Sealtite). Conduit will encase the load wires and ground wire from the safety disconnect switch to the blower motor. Conduit length not to exceed 4 feet (1.2 m) from disconnect to blower motor. The appropriate listed terminal fittings shall be used (per NEC Code 2020).

.10 Spark Resistant Blower: AMCA certified, designed and installed as a direct drive spark resistant blower. The motor shall meet current EPACT standards for energy savings. Fans utilizing belt drives and steel impellers will not be accepted.

.11 Optional Temperature Switch:

.1 One for each apparatus connected to the system. The temperature switch shall be of the snap disc type and adjustable from 90 deg. F (32 deg. C) to 130 deg. F (54 deg. C). It shall be mounted on the ductwork or on the trolley by drilling a 1 inch (25 mm) hole, sealing the switch with silicone sealant and securing with 2 self drilling screws. Can be used in conjunction with the optional wireless control system.

.2 Electrical connection shall be made with terminals provided or solder less type such as Thomas & Betts part no. 14RB-2577 or equivalent.

.12 Pressure Switch: One for each apparatus connected to the system. The pressure switch shall operate at a maximum of 24VAC, pre-calibrated at .18 in. of water column. Mounting shall be accomplished by drilling a 3/8 inch (9.5 mm) hole into the aluminum rail profile and thread the hole with a 1/8 inch NPT tap, then thread the switch into the rail. For wireless systems, mounting shall be accomplished by drilling a 3/8 inch (9.5 mm) into the hose connection of the trolley and threading the switch into the hole. The electrical connections shall be made with a 0.020 inch (.5 mm) by 0.187 inch (4.8 mm) female quick disconnect terminals, such as Thomas & Betts part no. 14RBD-18277 or equivalent.

Plymovent Fan Component Sizing Table 1-1

Single Phase 1Ø

Plymovent Product Number	Motor Manufacturer *	HP Rating	Name Plate		2023 NEC Table 430.248	Wire Size THHN	Length of Wire in Feet (Meters) Start to Finish		Circuit Breaker
			Voltage	FLA	Amps	AWG	From	To **	Size
FUA-1800-216	BALDOR	3/4	115	10	13.8	12	0	91 (27.7)	20A
			208-230	5.2-5	7.6-6.9	14	0	200 (61)	15A
FUA-2100-216	BALDOR	1	115	12	16	10	0	121 (36.8)	30A
			208-230	6.2-6	8.8-8	14	0	168 (51.2)	15A
FUA-2700-216	BALDOR	1.5	115	17	20	10	0	86 (26.2)	30A
			208-230	8.5	11-10	12	0	195 (59.4)	20A
TEV-359-216	BALDOR	2	115	20	24	10	0	73 (22.2)	30A
FUA-3000-216			208-230	11.4-10	13.2-12	12	0	145 (44.2)	20A
FUA-4700-216 TEV-3110-216	BALDOR	3	230	13	17	10	0	224 (68.2)	30A

TEV-559-216	BALDOR	5	230	19.8	28	8	0	235 (71.6)	30A
TEV-585-216	BALDOR	7.5	208-230	36-32	44-40	8	0	117 (35.6)	50A
	BALDOR	10	208	44	55	4	0	241 (73.4)	60A
TEV-745-216			230	41.5	50	6	0	177 (53.9)	60A
Three Phase 3Ø									
Plymovent Product No.	Motor Manufacturer	HP Rating	Name Plate Voltage	Name Plate FLA	2023 NEC Table 430.250 Amps	Wire Size THHN AWG	Length of Wire in Feet (Meters) Start to Finish From	Length of Wire in Feet (Meters) Start to Finish To *	Circuit Breaker Size
	BALDOR	3/4	208	2.5	3.5	14	0	482 (146.9)	15A
FUA-1800-536			230	2.4	3.2	14	0	555 (169.1)	15A
			460	1.2	1.6	14	0	2,222 (677.2)	15A
FUA-1800-636	BALDOR		575	1.3	1.3	14	0	2,564 (781.5)	15A
	BALDOR	1	230	3.2	4.2	14	0	416 (126.8)	15A
FUA-2100-536			460	1.6	2.1	14	0	1,666 (507.8)	15A
FUA-2100-636	BALDOR		575	1.2	1.7	14	0	2,777 (846.4)	15A
	BALDOR	1.5	208	4.4	6.6	14	0	274 (83.5)	15A
FUA-2700-536			230	4.05	6	14	0	329 (100.2)	15A
			460	2.05	3	14	0	1,300 (396.2)	15A
FUA-2700-636	BALDOR		575	1.6	2.4	14	0	2,083 (634.9)	15A
	BALDOR	2	208	5.2	7.5	14	0	231 (70.4)	15A
TEV-359-536			230	4.8	6.8	14	0	277 (84.4)	15A
FUA-3000-536			460	2.4	3.4	14	0	1,111 (338.6)	15A
TEV-359-636 FUA-3000-636	BALDOR		575	2	2.7	14	0	1,666 (507.8)	15A
TEV-3110-536	BALDOR	3	230	8	9.6	14	0	166 (50.5)	15A
FUA-4700-536			460	4	4.8	14	0	666 (203)	15A
TEV-3110-636 FUA-4700-636	BALDOR		575	3.05	3.9	14	0	1,092 (332.8)	15A
	BALDOR	5	230	12	15.2	12	0	176 (53.6)	20A
TEV-559-536			460	6	7.6	14	0	444 (135.3)	15A
TEV-559-636	BALDOR		575	4.7	6.1	14	0	709 (216.1)	15A
	BALDOR	7.5	230	18.4	22	10	0	183 (55.7)	30A
TEV-585-536			460	9.2	11	14	0	289 (88)	15A
TEV-585-636	BALDOR		575	7.4	9	14	0	450 (137.2)	15A
	BALDOR	10	230	23.6	28	8	0	228 (69.5)	40A
TEV-745-536			460	11.8	14	12	0	358 (109.1)	20A
TEV-745-636	BALDOR		575	9.5	11	14	0	350 (106.7)	15A
	BALDOR	15	230	35.5	42	6	0	240 (73.2)	60A
TEV-768-536			460	17.8	21	10	0	379 (115.5)	30A
TEV-768-636	BALDOR		575		17	10	0	0 ()	30A

***Note: Guidelines are subject to change without notice. Data supplied from our primary motor supplier. Please confirm at time of order. Plymovent assumes no liability for any electric installation, all local, city, and the 2023 National Electric Code must be followed. This chart is a minimum standard and to be used as a guideline only. Based on 3% voltage drop for branch circuits.**

**** Note: If distance is longer than the distance shown in the table, calculate for voltage drop per 2023 NEC.**

.18 **Air Moving Devices**

.1 Centrifugal Fans: Direct drive centrifugal type, high pressure, single width, single inlet as required or indicated. Impeller Wheels: Radial design or backward incline for performance, spark resistant and made of a nonferrous material to prevent static electricity build up. The impeller shall be dynamically and statically balanced and of the non-overloading type to provide maximum efficiency while achieving quiet, vibration-free operation. The fan housing shall be manufactured from a epoxy powder coated galvanized steel or nonferrous material. The outlet configuration shall be top horizontal, bottom horizontal, or upblast. The housing shall be capable of field reconfiguration in the event the mounting position needs to be changed for unforeseen reasons. The exhaust discharge outlet shall be in compliance with International Mechanical Code and ACGIH recommendations (min. of 36 inches (1 m) above roofline). Air intakes, windows, cascade systems, prevailing currents, communication equipment and building aesthetics shall be considered in the final location of the fan.
For aesthetic reasons the fan motor and assembly shall be mounted on a epoxy powder coated galvanized steel mounting base to prevent rust stains on the exterior of the building. Belt driven fans are unacceptable due to maintenance reasons and the potential for the fan to be left non-operational without warning.

.2 Fan Motor and Bearing: All 1/2 horsepower (373 watts) to 15 horsepower (11 kW) motors shall be totally enclosed fan cooled (TEFC) continuous duty rated. The motors shall be dual voltage where applicable. Motors shall comply with the government mandated "Energy Policy and Conservation Act" (EPACT) as outlined by the Department of Energy. The bearings shall be self-aligned, ball bearing type permanently sealed and lubricated.

.3 Performance: Lengths of ductwork, hoses, elbows, branches, wyes, etc. which increase the static pressure of the system, shall be taken into account to properly size the fan. The delivered volume shall be calculated taking into account the static regain of the vehicles engine exhaust (based on a virtually airtight connection at the tailpipe). The manufacturer's provided fan(s) shall be performance guaranteed by AMCA certification.

.1 Required Fan Capacity: The Fan Capacity shall be sized as such as to deliver the required CFM at each hose drop to which the vehicle is attached.

.1 The 4 inch (100 mm) hose system shall be designed to deliver a minimum of 340 CFM (577 m^3/h) at a velocity of 4500 FPM (23 m/s) at the hose and nozzle connection.

.2 The 5 inch (125 mm) hose system shall be designed to deliver a minimum of 540 CFM (917 m^3/h) at a velocity of 4500 FPM (23 m/s) at the hose and nozzle connection.

.4 Location: The preferable fan location shall be on the outside of the fire station as far away from any living quarters as possible so that firefighters would not be disturbed by the system activation. No blower fans shall be mounted inside the fire station. Silencers shall be provided when fan sound pressure level exceeds 64 dBA.

.19 **Ductwork System:**

.1 Ductwork Type and Materials: UMC Class 2 or SMACNA Class II product conveying duct, meet or exceed criteria for construction and performance as outlined in Round Industrial Duct Construction Standards, SMACNA. Materials of construction unless otherwise specified for all ductwork and fittings shall be a minimum G-90 galvanized sheet metal (ASTM A653/A653M). Only when specified, Type 304 stainless steel (ASTM A240/A240M) shall be provided.

.2 Ductwork Sizing and Gauges: Round pipe construction, with the range of available sizes not to exceed 16 inches (406 mm) in diameter. Duct gauge shall depend on diameter and a minimum operating pressure of 8 inches of water gauge (1993 Pa). Acceptable Gauge and Reinforcement Requirements: Inner duct diameter 4 inches (101 mm) through 11 inches (279 mm) diameter shall be 22 gauge standard pipe (International Mechanical Code).

.3 Ductwork Fittings: Round and have a wall thickness 2 gauges (one even gauge number) heavier than the lightest allowable gauge of the downstream section of duct to which they are connected (International Mechanical Code). Air Duct Branch Entrances: Factory fabricated fittings or factory fabricated duct /tap assemblies. Fittings: Constructed so that air streams converge at angles no greater than 45 degrees (International Mechanical Code). All Seams: Continuous stitch welded and if necessary, internally sealed to ensure air tightness. Turning elbows shall be stitch-welded and used for all diameters and pressures. They shall be fabricated of 24-gauge galvanized steel and constructed as two pieces with continuous welded seam construction fittings similar to those provided by Lindab Inc. Tapered Body Fittings: Used wherever particular fallout is anticipated and where air flow is introduced to the transport duct manifold.

.4 Ductwork Design Velocities: Minimum of 3500 FPM (18 m/s) to 4000 FPM (20 m/s) transport velocity. Capture Velocity: 4500 FPM (23 m/s) to 5500 FPM (28 m/s) to extract virtually 100 percent of the exhaust gases.

.5 External Ductwork: Sized for the exact inlet and outlet of the exhaust fan blower. An exhaust rain cap shall be supplied and manufactured in accordance with EPA standard for free draft rain cap requirements. Included as an integral part of this rain cap shall be a back draft damper to provide protection from rain and other inclement weather.

.6 Exhaust Penetrations: The core drilling shall be properly sized to reduce the diameter of the opening to the smallest possible size.

Part 3 - Execution

3.1 **VEHICLE EXHAUST EXTRACTION SYSTEM**

.1 Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, service-utility connections, and other conditions affecting installation and performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

.2 Provide surface/substrate preparation as required by the manufacturer's printed installation instructions. Do not proceed with installation is in proper condition to receive vehicle exhaust system installation.

.3 The successful vendor shall install vehicle exhaust system in accord with manufacturer's written instructions, original design and referenced standards.

.4 Adjust vehicle exhaust system for proper operation. Replace any parts that prevent the system from operating properly.

.5 Remove all debris caused by installation of the vehicle exhaust system. Clean all exposed surfaces to fabricated condition and appearance.

.6 Provide protection of the completed installation until completion of the project. Repair any damage at no additional cost to Owner.

.7 Provide training to fire department personnel in the daily use and maintenance of the vehicle exhaust removal system that has been installed and specified herein. The fire department shall be notified at least 7 days prior to the date scheduled for the training course. Training shall be for all personnel involved with the operation of the exhaust removal system to include all shifts required to man the particular facility. The Training session shall be performed in person by a recognized representative of the manufacturer of the exhaust removal system, in addition a training video shall be provided to the fire department.

.1 Provide training to all shifts during their normal shift period.

3.2 **FAN INSTALLATION - GENERAL**

.1 Install to manufacturer's written instructions.

.2 Install fans as indicated and specified with resilient mountings and flexible electrical leads. Refer to Section 23 05 48.

.3 Install flexible connections specified in Section 23 33 00 between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 25 mm (1 inch) flex between ductwork and fan while running.

.4 Install fan restraining snubbers as indicated. Refer to Section 23 05 48. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

.5 Provide sheaves required for final air balance.

.6 Provide safety screen where inlet or outlet is exposed.

.7 Provide backdraft dampers on discharge of exhaust fans and as indicated. Refer to Section 23 33 00.

3.3 **PANEL TYPE PROPELLER FAN**

.1 Fasten securely to wall and/or sheetmetal plenum.

.2 Install motorized damper complete with sheetmetal sleeve.

.3 Starter, disconnect and power wiring by Division 26.

.4 Control wiring by Division 25.

3.4 **CIRCULATING FANS - DESIGNATED HVLS-1, 2 etc.**

.1 Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog, and installation instructions.

.2 Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

.3 Verify that the fan is to be installed in a location where the airfoils will be a minimum of 10 feet above the finished floor with a minimum of 3 feet of clearance to any obstructions.

.4 If the fan is to be mounted in an area where materials or equipment may be elevated into its path, ensure that the floor is marked or painted to alert personnel of the overhead location of the fans.

.5 Verify that the placement of the fan will not interfere with correct sprinkler operation and that the fan installation complies with all national, state and local codes. For NFPA 13 compliance, fans must be installed in the center of four adjacent sprinklers with at least 3 feet of vertical clearance between the fan and sprinkler deflectors. Fans must also be interlocked to shut down upon receiving a waterflow signal from the building's alarm system.

.6 Check to see if the intended placement of the fan is directly below any building lights. Avoid installing fans directly below a light source to prevent a strobing effect that can be caused by fan rotation.

.7 For best performance, fans must be installed with a two fan diameter minimum clearance between the center of the fan and radiant heaters or HVAC system discharges or intakes.

.8 Verify that the mounting surface will bear the operating weight and maximum torque (twisting force) of the unit. The Structural Engineer of Record (SEOR) must perform a thorough evaluation of the mounting structure and determine all final mounting requirements before the fan is installed.

.9 Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction.

.10 Protect installed product and finished surfaces from damage during construction.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 VRV System Ductless Split System.

.2 Refrigerant Piping

1.2 RELATED SECTIONS

.1 Section 01 11 00 - General Instructions & Summary of Work: Owner provided equipment.

.2 Section 23 21 00 - Hydronic Piping: Connections to heating coils.

.3 Section 23 21 16 - Hydronic Specialties: Connections to heating coils.

.4 Section 23 31 00 - Duct Work.

.5 Section 23 33 00 - Duct Work Accessories.

.6 Section 23 37 00 - Air Outlets and Inlets.

.7 Section 25 50 02 - Digital Control Equipment: Thermostats and Actuators.

.8 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ADC 1062: GRD-84 - Test Code for Grilles, Registers and Diffusers.

.4 NFPA 90A - Standard for Installation of Air Conditioning and Ventilating Systems.

.5 UL 181-2013 - Standard for Factory-Made Air Ducts and Air Connectors.

.6 CSA (Canadian Standards Association).

.7 UL (Underwriters Laboratories Inc.).

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalogue performance ratings which indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

.3 Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 250 to 1000 Pa (1 to 4 inch wg).

.3 Installation Data: Manufacturer's special installation requirements including support and hanging details, and service clearances required.

1.6 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

.3 Record Documentation: Record actual locations of units controls components.

.4 Warranty Documentation.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials: Provide two (2) additional electric motors of each size.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) documented experience.

.3 Performance Tolerance: Base performance on tests conducted to ADC 1062: GRD.

1.9 **REGULATORY REQUIREMENTS**

.1 Products Requiring Electrical Connection: Listed and classified by CSA UL and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.10 **WARRANTY**

.1 Provide five (5) year warranty, including coverage of system powered control systems, operating controls and electric motors.

Part 2 - Products

2.1 **VRF SPLIT SYSTEMS - DESIGNATED FCU/VRF CU (LOWER LEVEL, LEVEL 1)**

.1 Manufactures:

.1 Design is based on Mitsubishi

.2 Acceptable Products:

.1 Mitsubishi
.2 LG
.3 York Hitachi
.4 Samsung

.3 **Outdoor Units**

.1 General:

.1 The outdoor unit modules shall be air-cooled, direct expansion (DX), multi-zone units used specifically with VRF components described in this section and under Controls. The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards-all of which must be manufactured by the branded VRF manufacturer. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.

.2 Outdoor unit systems may be comprised of multiple modules with differing capacity if a brand other than basis of design is proposed. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.

.3 Outdoor unit shall have a sound rating no higher than 65 dB(A) individually or 70 dB(A) twinned. Units shall have a sound rating no higher than 52 dB(A) individually or 54.5 dB(A) twinned while in night mode operation. Units shall have 5 levels sound adjustment via dip switch selectable fan speed settings. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.

.4 The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.

.5 The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via Linear Expansion Valves (LEV) from the heat exchanger.

.6 The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.

.7 VRF system shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.

.8 The outdoor unit shall be capable of guaranteed operation in heating mode down to -13 deg. F ambient temperatures, simultaneous heating/cooling mode from 14-70 deg. F ambient temperatures, and cooling mode up to 109 deg. F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range published as "for reference only" are not considered capable of guaranteed operation and are not acceptable. If an alternate manufacturer is selected, any additional material, cost, and labor to meet ambient operating range and performance shall be incurred by the contractor.

.9 The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.

.10 Unit must defrost all circuits simultaneously in order to resume full heating more quickly during extreme low ambient temperatures (below 23F). Partial defrost, also known as hot gas defrost which allows reduced heating output during defrost, is permissible only when ambient temperature is above 23F.

.11 While in hot gas defrost the system shall slow the indoor unit fan speed down to maintain a high discharge air temperature, systems that keep fan running in same state shall not be allowed as they provide an uncomfortable draft to the indoor zone due to lower discharge air temperatures.

.2 Unit Cabinet:

.1 The casing(s) shall be fabricated of galvanized steel, bonderized and finished.

.2 Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised and the panel should be replaced immediately.

.3 Fan:

.1 Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. wg external static pressure, but capable of normal operation with a maximum of 0.32 in. WG external static pressure via dipswitch.

.2 All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.

.3 All fans shall be provided with a raised guard to prevent contact with moving parts.

.4 Refrigerant and Refrigerant Piping:

.1 R410A refrigerant shall be required for systems.

.2 Polyolester (POE) oil-widely available and used in conventional domestic systems-shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

.3 Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.

.4 All refrigerant piping must be insulated with 1/2" closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.

.5 Refrigerant line sizing shall be in accordance with manufacturer specifications.

.5 Coil:

.1 Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil.

.2 Outdoor Coil shall be elevated at least 12" from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturer's in which their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12" of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basis of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be responsibility of Mechanical Contractor to provide.

.3 The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.

.4 The coil fins shall have a factory applied corrosion resistant blue-fin finish. Uncoated aluminum coils/fins are not allowed.

.5 The coil shall be protected with an integral metal guard.

.6 Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

.7 Unit shall have prewired plugs for optional panel heaters when operating below ambient conditions of 1F to prevent any residual ice buildup from defrost.

.8 Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed to bid on project in markets where the outdoor unit will see temperatures below freezing.

.6 Compressor:

.1 Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer's that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.

.2 Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.

.3 Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase heaters are not allowed. Manufacturers that utilize belly-band crankcase heaters will be considered as alternate only.

.4 Compressor shall have an inverter to modulate capacity. The capacity for each compressor shall be variable with a minimum turndown not greater than 15%.

.5 The compressor shall be equipped with an internal thermal overload.

.6 Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

.7 Manufacturers that utilize a compressor sump oil sensor to equalize compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.

.7 Controls:

.1 Outdoor unit shall include Variable Evaporator Temperature or comparable method of varying system evaporator (refrigerant) temperature in order to reduce compression ratio and power consumption during light load or mild ambient temperatures. Multiple evaporator refrigerant temperature settings shall be required in order to optimize efficiency within required system-specific performance and installation constraints. System shall reduce compression ratio only when/if all indoor units are within 1.8F of setpoint; reducing compression ratio based solely on ambient temperature risks discomfort and is not allowed. Variable Evaporator Temperature or comparable method shall incorporate override or disable capability based on external signal to allow for space humidity control or load demand.

.2 The unit shall be an integral part of the system & control network described in Part 5 (Controls) and react to heating/cooling demand as communicated from connected indoor units over the control circuit. Required field-installed system controllers, control voltage transformers and/or signal boosters shall be provided by the manufacturer.

.3 The outdoor unit shall have the capability of 4 levels of demand control for each refrigerant system based on external input.

.8 Electrical:

.1 The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz or 460 volts, 3-phase, 60 hertz per equipment schedule.

.2 The outdoor unit shall be controlled by integral microprocessors.

.3 The control circuit between the indoor units and the outdoor unit shall be 24 VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

.4 **Indoor Units:**

.1 General: The ceiling-concealed ducted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

.2 Unit Cabinet:

.1 The unit shall be ceiling-concealed, ducted-with a 2-position, field adjustable return and a fixed horizontal discharge supply.

.2 The cabinet panel shall have provisions for a field installed filtered outside air intake.

.3 Fan:

.1 Indoor unit shall feature multiple external static pressure settings ranging from 0.14 to 0.60 in. WG.

.2 The indoor unit fan shall be an assembly with statically and dynamically balanced Sirocco fan(s) direct driven by a single motor with permanently lubricated bearings.

.3 The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function

.4 Filter: Return air shall be filtered by means of a standard factory installed return air filter.

.5 Coil:

.1 The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with Phos-copper or silver alloy.

.2 The coils shall be pressure tested at the factory.

.3 Coil shall be provided with a sloped drain pan. Units without sloped drain pans which must be installed cockeyed to ensure proper drainage are not allowed.

.4 The unit shall be provided with an integral condensate lift mechanism able to raise drain water 27 inches above the condensate pan.

.6 Electrical:

.1 The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

.2 The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

.7 Controls:

.1 Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

.2 Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F - 9.0°F adjustable deadband from set point.

.3 Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

.4 Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

.5 Control board shall include contacts for control of no less than two stages of external heat. The first stage of external heat may be energized when the space temperature is 2.7°F from set point for between 10-25 minutes (user adjustable). The second stage of external heat may be energized when the first stage has been active for no less than 5 minutes and the space temperature has not risen by more than 0.9°F.

.6 Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

.7 Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

.5 **Automation Controls**

.1 Overview:

.1 The control system shall consist of a low voltage communication network and a web-based interface. The controls system shall gather data and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

.2 Furnish energy conservation features such as optimal start, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.

.3 System shall be capable of email generation for remote alarm annunciation.

.2 General:

.1 Controller power and communications shall be via a common non-polar communications bus and shall operate at 30 VDC.

.2 Wiring:

.3 Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

.4 Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.

.3 Wiring type:

.1 Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.

.2 Network wiring shall be CAT-5 with RJ-45 connection.

.3 City Multi Controls Network: The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces.

.4 Wired MA Remote Controller:

.1 The Backlit Wired MA Remote Controller shall be capable of controlling up to 16 indoor units (defined as 1 group).

.2 The Backlit Wired MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers or with other Backlit Wired MA Remote Controllers, with up to two remote controllers per group.

Wired MA Remote Controller			
Item	**Description**	**Operation**	**Display**
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat. Operation modes vary depending on the air conditioner unit. Auto mode is available for the R2/WR2-Series only.	Each Group	Each Group
Temperature Setting	Sets the temperature from 67°F - 87°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group

Wired MA Remote Controller			
Item	**Description**	**Operation**	**Display**
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Vane, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing a button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display "test run").	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.	Each Group	N/A
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group
Schedule	Set up to 8 operations per day, 7 days per week. Operations include time on/off, mode and room temperature set point.	Each Group	Each Group

Part 3 - Execution

3.1 **VRF SPLIT SYSTEMS - DESIGNATED FCU/VRF CU**

.1 **Delivery, Storage and Handling:**

.1 Units shall be stored and handled according to the manufacturer's recommendations. Units shall be kept clean and isolated from dust and debris.

.2 Contractor shall inspect all equipment upon delivery and notify shipping company and manufacturer immediately of any damage.

.2 **Installation:**

.1 Install condensing units on a flat surface level within 1/8 inch, and elevated a minimum of 18" from ground or roof surface. Provide intermediate supports as recommended by the equipment manufacturer.

.2 Provide all necessary control wiring as recommended by the manufacturer.

.3 High/low pressure gas line, liquid, and suction lines must be individually insulated between the outdoor and indoor units.

.4 Contact manufacturer prior to installation to review and confirm piping layout and lengths.

.5 Use refrigeration best practice to allow pipes to expand and contract freely. Review manufacturer installation instructions to ensure expansion joints are properly designed.

.6 Pressure test ALL systems to 550 PSI after system was vacuumed and held to below 500 microns for at least one hour. Review manufacturer installation instructions for proper pressure test procedures.

.7 Design and install all piping as per TSSA and CSA B52 regulations, and apply and obtain TSSA certification for all systems.

3.2 **REFRIGERANT PIPING**

.1 Install filter, dryer, sight glass and thermal expansion valve on each system.

.2 Hot gas lines to be complete with oil traps.

.3 Piping outdoors to be mounted on roof sleepers. See Typical Piping Roof Support Detail on Mechanical Drawings. Provide neoprene cover to eliminate vibration and wear.

.4 Insulate all liquid and suction lines with 1/2" (15 mm) Armaflex II pipe insulation sealed at joints with Armstrong 520 adhesive.

.5 VRV Refrigeration pipe systems to be tested with nitrogen to 550 psig (3800 kPa) for twenty-four (24) hours and leaks repaired and piping retested before insulation is applied.

.6 Roof pipe sleeve shall be supplied by Division 23 and installed by the General Contractor. Co-ordinate with Division 23.

.7 Roof pipe sleeve shall be supplied by and installed by the Owner approved Roofing Consultant/ Contractor. Co-ordinate with Division 23.

.8 After Refrigerant pipe installation is complete and tested, supply and charge each system with the correct quantity of oil and refrigerant.

.9 Fully pipe up evaporator and associated air cooled condenser unit as per Manufacturers installation instructions.

.10 After the refrigerant pipe installation is complete and tested, supply and charge each system with correct quantity of oil and refrigerant.

.11 Division 23 to supply and install the refrigerant piping: leak test piping; evacuate the pipework; charge the system with additional refrigerant; and connect control wiring to indoor and condensing units. The installing Contractor shall be required to attend Manufacturer's training and submit training certification proof.

.12 The VRF system Manufacturer to provide training to installing Contractor, and provide CAD Drawing of all refrigerant piping complete with connections, transitions, joint locations, and sizes.

.13 Refrigerant piping shall be hung from cushion clamps, secured to unistrut, hung from threaded hanging rods. Minimum length of hanging rods to be 12" (300 mm). Install neoprene cover around pipe to prevent vibration and wear. Cushion clamps are to be loosely secured to refrigerant pipe to allow for expansion/contraction. Do not secure unistrut directly to interior walls or underside of concrete structural slab.

.14 Supply and install every 50'-0" (15000 mm) in the refrigeration piping system, an expansion loop. Supply and install pipe anchors where noted on the Drawings.

.15 Division 22 shall pipe the drain pan to drain with trap. Provide interlock relay between condenser and remote fan coil units. Each system shall be complete with programmable wall mounted thermostat.

.16 Division 26 will wire power to each fan coil unit and condensing unit. Division 23 is to Provide control wiring from each fan coil unit to each condensing unit in a daisy chain configuration. Division 23 is to run controls to operate the fan and cooling. Division 23 to install and wire programmable thermostat/VRF Controller.

.17 This Section shall secure all outdoor condensing units to the structural frame on the roof.

.18 Refrigerant piping and condensate drainage piping shall be installed concealed within building structure. Pipe is not to run exposed.

.19 Contractor to ensure that outdoor air cooled condensing units are elevated a minimum of 450 mm (18").

.20 Contractor to contact Manufacturer with any changes to pipe lengths or locations and receive revised piping and wiring diagrams which will be used for sizing pipe diameters and calculating refrigerant charge.

.21 Contractor to confirm final location of condensing units.

.22 Contractor to schedule a site meeting with Manufacturer's technician prior to beginning piping installation. Manufacturer may request to schedule a site visit to verify installation methods are in accordance with Manufacturer requirements.

.23 Control wiring is 18 AWG, 2 wire stranded, non-shielded for the entire system (control wiring between the fan coils and stats). No exception.

.24 Contractor to pressure test system with nitrogen to the following procedure: 150 (1035 kPa) psi for 3 minutes, then 325 psi (2240 kPa) for 3 minutes, then 550 psi (3800 kPa) for 24 hours. Following the pressure test, the system is to be vacuumed/dehydrated to 500 microns and held in a vacuum for 12 hours.

.25 Refrigerant charge is be calculated by the Manufacturer as per the actual installed pipework.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Diffusers.

.2 Registers/grilles.

.3 Louvres.

1.2 RELATED SECTIONS

.1 Section 09 91 22 - Painting: Painting of duct work visible behind outlets and inlets.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 ADC 1062: GRD-84 - Test Code for Grilles, Registers and Diffusers.

.4 AMCA 500-L-12 - Laboratory Methods of Testing Louvers for Rating.

.5 AMCA 500-D-12 - Laboratory Methods of Testing Dampers for Rating.

.6 ASHRAE 70-2006 (RA 2011) - Method of Testing the Performance of Air Outlets and Air Inlets.

.7 NFPA 90A -Standard for Installation of Air Conditioning and Ventilating Systems.

.8 SMACNA 1966-2005 - HVAC Duct Construction Standards - Metal and Flexible.

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Manufacturer's special installation requirements.

1.6 CLOSEOUT SUBMITTALS

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of air outlets and inlets.

1.7 QUALITY ASSURANCE

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Test and rate louvre performance to AMCA 500-L.

.3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

Part 2 - Products

2.1 **ROUND CEILING DIFFUSERS**

.1 Type: Round, adjustable pattern stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sectorizing baffles where indicated. Project diffuser collar maximum 25 mm (1 inch) above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.

.2 Fabrication: Steel with baked enamel off-white finish.

.3 Accessories: Butterfly damper and multi-louvred equalizing grid with damper adjustable from diffuser face.

2.2 **SQUARE CEILING DIFFUSERS**

.1 Type: Square, stamped, multi-core, adjustable pattern diffuser to discharge air in four-way pattern with sectorizing baffles where indicated.

.2 Frame: Snap-in type to suit the ceiling construction

.3 Fabrication: Aluminum with baked enamel off-white finish.

.4 Accessories: Butterfly damper and multi-louvred equalizing grid with damper adjustable from diffuser face.

2.3 **CEILING SUPPLY REGISTERS/GRILLES**

.1 Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.

.2 Frame: 25 mm (1 inch) margin with countersunk screw concealed mounting and gasket.

.3 Fabrication: Aluminum extrusions with factory off-white enamel finish.

.4 Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.4 **CEILING EXHAUST & RETURN REGISTERS/GRILLES**

.1 Type: Streamlined blades, 19 mm (3/4 inch) minimum depth, 19 mm (3/4 inch) maximum spacing, with blades set at 45 degrees.

.2 Frame: 25 mm (1 inch) margin with countersunk screw concealed mounting.

.3 Fabrication: Steel with 0.9 mm (20 ga) minimum frames and 0.8 mm (22 ga) minimum blades, steel and aluminum with 0.9 mm (20 ga) minimum frame, or aluminum extrusions, with factory off-white enamel/baked enamel/prime coated/ clear lacquer finish colour to be selected.

.4 Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

.5 Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.5 **CEILING LINEAR EXHAUST & RETURN GRILLES**

.1 Type: Streamlined blades with 90 degree two-way deflection, 3.2 x 19 mm (1/8 x 3/4 inch) on 6 mm (1/4 inch) centres.

.2 Frame: 25 mm (1 inch) margin, extra heavy for floor mounting with countersunk screw concealed mounting.

.3 Fabrication: Steel with 0.9 mm (20 ga) minimum frames and 0.8 mm (22 ga) minimum blades, steel and aluminum with 0.9 mm (20 ga) minimum frame, or aluminum extrusions, with factory off-white enamel/baked enamel/prime coated/ clear lacquer finish, colour to be selected.

.4 Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.6 **LOUVRES**

.1 Type: 100 mm (4 inch) or 150 mm (6 inch) deep with blades on 45 degree slope with centre baffle and return bend, heavy channel frame, birdscreen with 13 mm (1/2 inch) square mesh for exhaust and 19 mm (3/4 inch) for intake.

.2 Fabrication: Welded assembly; colour to be selected.

.1 1.5 mm (16 ga) thick galvanized steel.

.2 2.5 mm (12 ga) thick extruded aluminum.

.3 Mounting: Provide with interior flat flange, exterior flat flange, interior angle flange, exterior angle flange, screw holes in jambs, masonry strap anchors as appropriate for installation.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

.3 Install diffusers to duct work with air tight connection.

.4 Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

.5 Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 91 22.

END OF SECTION

Part 1 - General

1.1 **SECTION INCLUDES**

.1 Heating Boilers.

.2 CO_2 Domestic Water Heat Pumps.

.3 Controls.

.4 Hot water connections.

.5 Hot Water Storage Tanks.

1.2 **RELATED SECTIONS**

.1 Section 03 30 00 - Cast-in-place Concrete.

.2 Section 23 21 16 - Hydronic Specialties.

.3 Section 25 50 02 - Digital Control Equipment.

.4 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 **REFERENCES**

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 AGA - Directory of Certified Appliances and Accessories.

.4 CSA 4.9/ANSI Z21.13 - Gas-Fired Low Pressure Steam and Hot Water Boilers.

.5 ASME Boiler and Pressure Vessels Code (BPVC), Section I - Rules for Construction of Power Boilers.

.6 ASME Boiler and Pressure Vessels Code (BPVC), Section IV - Rules for Construction of Heating Boilers.

.7 ASME Boiler and Pressure Vessels Code (BPVC), Section VIII - Rules for Construction of Pressure Vessels.

.8 NEMA 250 - Enclosures for Electrical Equipment (1000 Volt Maximum).

.9 CSA (Canadian Standards Association).

.10 UL (Underwriters Laboratories Inc.).

.11 UL 834

.12 D.NSF/ANSI 61/372 - Drinking Water System Components

.13 NEC, National Electric Code

1.4 **SUBMITTALS FOR REVIEW**

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.

.3 Shop Drawings: Indicate general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Submit manufacturer's installation instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.

.3 Manufacturer's Certificate: Certify that units meet or exceed specified requirements.

.4 Manufacturer's Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.

1.6 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Maintenance Contracts: Provide service and maintenance of boilers for one (1) year from Date of Substantial Completion.

.3 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

.4 Warranty Documentation.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Tools: Provide wire brush and hinged handle for tube cleaning.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

.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 **REGULATORY REQUIREMENTS**

.1 Conform to ASME BPVC-Section IV for boiler construction.

.2 Units: "AGA certified", "UL labeled".

.3 Conform to "applicable code" "NFPA 70" for internal wiring of factory wired equipment.

.4 Products Requiring Electrical Connection: Listed and classified by CSA UL and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.10 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.11 **WARRANTY**

.1 Provide warranties as listed below.

Part 2 - Products

2.1 **MANUFACTURERS**

.1 Design is based on Fulton FB-W

.2 Acceptable Products:

.1 Fulton
.2 Laars
.3 Cleaver Brooks
.4 Electro Industries

2.2 **ELECTRIC BOILERS - DESIGNATED B-1**

.1 **Construction:**

.1 The boiler shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping.

.2 The pressure vessel design and construction shall be in accordance with Section IV of the ASME Code for heating boilers (Section I optional for high temperature boilers). The boiler shall comply with CSD-1 code requirements and carry a UL listing (CAS/CUL approval for Canada - CAN/CSA-C22.2 No. 165-92).

.3 The pressure vessel shell and heads shall be SA-53B ERW pipe or SA-516 Grade 70 plate and have the following thickness (160 psig design):

FB-W Model (HP)	Shell (Inches)	Head (Inches)
1.2	0.375	0.625
1.5	0.375	0.625
1.8	0.375	0.625
2.4	0.375	0.5
3.0	0.375	0.5
3.6	0.375	0.5
7.0	0.375	0.5
10.5	0.375	0.5
14.0	0.375	0.625
17.5	0.313	0.625
21.0	0.313	0.625

FB-W Model (HP)	Shell (Inches)	Head (Inches)
28.0	0.313	1.0
35.0	0.313	0.75
42.0	0.313	0.75
49.0	0.313	1.0
56.0	0.375	0.75
63.0	0.375	0.75
70.0	0.375	0.75

.4 Boiler shall be covered with a blanket type, high temperature insulation.

.5 The metal jacket shall have a primer and finish coats of paint.

.2 **Boiler Design:**

.1 The boiler shall be a vertical design with adequate openings for access to the water side of the boiler.

.2 Boiler shall be supplied with resistance type heating elements with 321 stainless steel sheathing to ensure longer life.

.3 The heating elements shall have a watt density not to exceed 75 Watts per square inch.

.4 The water volume of the boiler shall not be less than 13 Gallons (49 liters)

.3 **Controls:**

.1 Boiler safety controls shall include:

.2 Operating Temperature Controller for automatic start and stop of boiler operation.

.3 High Limit Temperature Controller with manual reset.

.4 PID type operating temperature controller with digital display (units with step sequencer only only).

.5 A probe type low water cut-off to cause a shut-down of unit should the water level drop to an unsafe level.

.6 Element Step Sequencer Controller for boilers 105 kW (10.5 HP) and above: Modulation of boiler capacity shall be by a solid state step controller capable of either fully automatic or manual operation. Step controller shall be the first on/first off type to equally exercise all heating elements. Step controller will incorporate a field adjustable timed intermittent (X seconds on, Y seconds off) cycle to minimize fluctuations in temperature.

.7 All controls to be panel mounted in a NEMA 3X enclosure and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. Panel shall be located to prevent possible damage by water or heat. Controls connected to water or steam shall be installed outside the main boiler control panel. All controls shall be mounted and wired according to Underwriters' Laboratories requirements.

.4 **Boiler Fittings & Trim:**

.1 The boiler shall be supplied with an ASME Section IV safety relief valve (Section I valve for Section I vessels). The safety relief valve size shall be in accordance with ASME code requirements and set at 160 psig for Section IV Pressure Vessels. Custom set pressures upon request.

.2 A combination temperature/pressure gauge shall be included with the boiler.

.3 The boiler shall come set up for transporting by fork lift.

.4 Instructions for installation, operation and maintenance of the boiler shall be contained in a manual provided with each boiler.

.5 A wiring diagram corresponding to the boiler configuration shall be included with each boiler.

2.3 **CO_2 DOMESTIC WATER HEATER - DESIGNATED WH-1 (OU), WH-2 (OU)**

.1 **General:**

.1 Basis of Design is Transom Corporation.

.2 The heat pump water heater shall be constructed to meet the requirements of UL 60335-2-40 / CSA C22.2 No. 60335-2-40; 3rd Edition or later, to be certified by one or more nationally-recognized testing laboratories

.3 All components in the product are recognized and or listed by one or more third party agencies (UL, ETL, CSA, CE) for use in this product application.

.4 All components, materials, and accessories as new and free from defects.

.5 Heat Pump is factory-tested for intended performance specifications prior to shipping.

.2 **General Construction:**

.1 Heat Pump Water Heater shall be shipped complete as a factory-packaged, tested and certified unit for performance and safety under all specified operating conditions.

.2 Heat Pump Water Heater shall be certified to operate at ambient temperatures as low as -20 deg. F without the need for supplemental heat, and as high as 115 deg. F, and capable of producing potable water of no less than 190 deg. F.

.3 Chassis and integral frame shall be constructed entirely of steel and/or aluminum sheet metal, framing and weldments/fasteners, with anti-corrosion coating and shall have large removeable panels on all sides for ease of access during maintenance and installation.

.4 Refrigerant piping shall be constructed CuFe alloy with silver-alloy brazing, certified to be leak-free at all refrigerant working pressures.

.5 All water-side components and materials used for their assembly are appropriate for direct contact with potable water.

.3 **Refrigerant Type:**

.1 Refrigeration circuit shall be factory-charged with refrigerant R744 (carbon dioxide CO_2).

.2 Use of alternative refrigerant is not acceptable.

.4 **Compressor:**

.1 Compressor shall be variable-speed, fully-serviceable, semi-hermetic reciprocating-type purposely designed for heating with refrigerant R744. The compressor shall be equipped with thermal overload protection, oil level indicator, pressure safety relief valves, service valves and crankcase electrical heater and is mounted on rubber vibration dampers to reduce the transmission of vibrations.

.2 Compressor safety controls include redundant mechanical high- and low-pressure switches certified to UL 353. Thermal motor safety overload protection is integral to the compressor and interlocked with compressor power contactor.

.3 A crankcase heater shall be included.

.5 **Source Side Evaporator:**

.1 Evaporator shall be constructed of heavy-duty copper tubes and aluminum fins with a large exchange surface area suitable for the specified ambient conditions.

.2 DEFROST

.3 The system evaporator air-side heat exchanger shall have an intelligent defrost cycle based on suction pressure, ambient temperature and time, with allowable adjustments, including for fixed defrost temperature and/or termination time.

.4 Defrost must be accomplished by integral electric resistance heating elements or direct injection of hot discharge gas to minimize defrost time duration. Units that defrost based on a reverse-cycle are not acceptable.

.5 Unit to include electric resistance heat tracing factory-fitted at the bottom of the condensation collection tray and internal piping to ensure the outflow of water into the drain.

.6 **Load Side Gas Cooler:**

.1 Gas Cooler shall be constructed of 316 stainless steel with copper alloy brazed plates, incorporating double-wall, vented construction, suitable for use with potable water. Single-wall construction and/or secondary water glycol loop is not acceptable.

.2 Gas Cooler is certified for full working capacity and at not less than 130 bar working pressure.

.7 **Refrigeration Accessories:**

.1 Circuit shall include all components necessary for ease of service, optimal performance and maximum longevity.

.2 Refrigeration system components to be included, but not limited to, are: manual/automatic valves, refrigerant/oil filter, high-pressure switch, safety relief valves, modulating head-pressure control valve, suction accumulator, high and low pressure transducers and SAE flare-type service access ball-valves/fittings appropriate for the working pressures.

.3 An auxiliary refrigerant expansion vessel shall be provided to allow optimal charge level to be maintained during the full range of operating conditions, and for maintaining pressure and refrigerant integrity during off-cycle at up to 125 deg. F ambient. Refrigerant blow-off is not acceptable during high-ambient (less than 125 deg. F) conditions.

.8 **Electronic Control Valves:**

.1 Electronically-actuated valves shall intelligently regulate all system functions.

.2 A discharge pressure regulating valve shall be stepper-motor actuated by the PLC.

.3 The discharge pressure regulating valve shall continuously regulate trans-critical head pressure to maintain optimal COP under all conditions.

.9 **Fans:**

.1 All fans shall be directly coupled to the EC motor with external rotor, protection rated to minimum IP 54. Fan speed shall continuously vary, running at minimum speed necessary for minimal sound and optimal efficiency.

.2 Standard outdoor vertical discharge axial fans. Fans shall be installed in shaped housings and include a protective safety grille.

.10 **Water Circuit:**

.1 The Heat Pump water circuit shall be constructed of heavy wall copper alloy piping suitable for potable water.

.2 The system shall incorporate optional integral electric resistance heating to provide auxiliary and partial backup heating without the need for external auxiliary heating.

.11 **Water Circulation Pump:**

.1 An integral water circulator shall be variable speed, ECM. Pump speed to be automatically controlled by control system for maintaining heating outlet temperature setpoint.

.2 Integral pump shall be stainless steel and suitable for potable water applications.

.12 **Electrical Panel:**

.1 Electrical Panel shall be built by a shop certified to UL508A standard.

.2 Electrical Panel shall consist of fully-wired power distribution, fuses, circuit breakers and

.3 disconnect switch to protect all electrical devices.

.4 Electrical panel shall have a single-point power connection.

.5 Electrical panel shall have integrally-wired, main-power monitoring system.

.6 Electrical Panel shall include low-voltage PLC controls programmed for

.7 managing all system functions and operator indications.

.8 All electrical components shall be safety-certified for this usage.

.13 **Electronic Control System:**

.1 The Heat Pump shall include a PLC Control System for user input to select leaving water temperature, and reliably manage all electronic system functions and commissioning.

.2 Control system shall include a surface-mount touch-screen or LCD display, such to provide access for all system indications and control functions.

.3 The Control System shall include security password protection for accessing low-level adjustability and service diagnostic information.

.4 The Control System shall display system performance, real-time energy consumption and calculated COP based on heat generated and electrical energy going in.

.5 The Heat Pump control shall provide constant outlet temperature in single-pass configuration by automatically varying capacity and flow under specified inlet and ambient conditions. Control valves that restrict flow or mix water for maintaining outlet temperature are not acceptable.

.6 The Control shall automatically modulate auxiliary electric heating under low-ambient conditions without user intervention such to maintain temperature, and without any additional power supply.

.14 **Communications:**

.1 The heat pump water heater shall include low-voltage dry contacts for remote alarm

.2 indication.

.3 The heat pump water heater shall be capable to communicate via Modbus Ethernet TCP / RS485

.4 The heat pump water heater shall be capable to communicate via BACnet IP / BACnet MSTP

.5 Auxiliary Resistance Heating

.1 Optional electric resistance backup heaters shall be incorporated in the water side, providing heating if the refrigeration system is unable to maintain outlet temperature. Heaters are interlocked with compressor such that rated power remains within specified full load amperage listed on the nameplate. Heater output is controlled via solid state relays via the on-board PLC control system.

.6 Optional electric resistance trim heaters shall be incorporated in the water side. If enabled, trim heating shall be modulated to maintain selected output temperature, if the refrigeration capacity is unable. Heater output shall remain within specified full load amperage specification listed on the nameplate.

2.4 **DOMESTIC HOT WATER STORAGE TANK & CIRCULATING PUMPS - DESIGNATED ST-1**

.1 **Construction:**

.1 The storage tank shall be ASME HLW stamped and National Board Registered for a maximum allowable working pressure of 150 psi and pressure tested at 1-1/2 times working pressure.

.2 All tank connections/ fittings shall be nonferrous. Tank design will include a manway sized access to the tank interior.

.3 The storage tank shall be an unlined pressure vessel constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923 Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2 and ASTM G123 - 00(2005) "Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution."

.4 Waterside surfaces shall be welded internally utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.

.5 All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.

.6 Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.

.7 Water contacting tank surfaces will be non-porous and exhibit 0% water absorption.

.8 Lined or plated storage tanks will not be acceptable.

.9 The storage tank will not require anodes of any type and none will be used.

.2 **Performance:** Water heater will meet the tank insulation requirements of ASHRAE 90.1-2016

.3 **Water Heater Trim:**

.1 ASME-rated temperature and pressure relief valve

.2 Installation kit

Part 3 - Execution

3.1 **INSTALLATION - ELECTRIC BOILER**

.1 Equipment and materials shall be installed in an approved manner and in accordance with the boiler manufacturers' installation requirements.

.2 The installer shall construct a flat, level foundation designed to support the entire load. Calculations shall be based upon the maximum or filled weight of the system. The boiler should be located in dry surroundings on a level base, making sure that there is sufficient room around the boiler to enable the operator and/or the maintenance engineer to gain access to all parts of the boiler. Check location for ease of water supply and electrical connections. Place the boiler on a non combustible floor with clearances to unprotected combustible materials, including plaster or combustible supports.

.3 Assemble unit sections and parts shipped loose or unassembled for shipment purposes. Follow manufacturer's installation recommendations and instructions.

.4 Install electrical control items furnished by manufacturer per wiring diagram provided by manufacturer.

.5 Complete system piping as required by manufacturer for operation of system. Install circulator on boiler. Pipe relief to nearest floor drain.

.6 After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator.

.7 Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boilers and piping. Obtain certification for completed boiler units, deliver to Owner, and obtain receipt

3.2 INSTALLATION - CO_2 DOMESTIC WATER HEAT PUMP

.1 All integral system piping shall be completed by the manufacturer prior to shipping. External water-side, electrical power and remote communications field connections to be made by installing contractor.

.2 Connection dimensions for the domestic water in and out shall be 1" NPT male, factory-tested to 100 psi. Condensate drain shall be 1" NPT male.

.3 Factory-authorized service representative to provide initial commissioning of the heat pump water heater, inspect components, assemblies, and interconnecting equipment, including piping and electrical connections, and to assist in system testing and training upon completion of the startup.

3.3 INSTALLATION - DOMESTIC WATER STORAGE TANK

.1 Install storage tank level and plumb in accordance with manufacturers written instructions and referenced standards.

.2 The storage tank shall be completely factory packaged on a single skid, requiring only job site hookup to plumbing. The heater shall be insulated to ASHRAE 90.1-2016 requirements, jacketed with enameled steel panels, and mounted on heavy-duty channel skids. The heater shall fit properly in the space provided and installation shall conform to all local, state, and national codes.

3.4 SCHEDULES

.1 Refer to Schedule on Drawings.

END OF SECTION

Part 1 - General

1.1 **SECTION INCLUDES**

.1 Dehumidifier.

.2 Energy Recovery Ventilators

1.2 **RELATED SECTIONS**

.1 Section 22 10 00 - Plumbing Piping: Equipment drains.

.2 Section 23 05 16 - Piping Expansion Compensation.

.3 Section 23 05 48 - Vibration Isolation.

.4 Section 23 07 13 - Duct Insulation.

.5 Section 23 31 00 - Duct Work.

.6 Section 23 33 00 - Duct Work Accessories: Flexible duct connections.

.7 Section 23 34 16 - Commercial Fans.

.8 Section 23 40 00 - Air Cleaning Devices.

.9 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 **REFERENCES**

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

.4 AHRI 430 - Central-Station Air-Handling Units.

.5 AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.6 AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.7 AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.

.8 AMCA 99-10 - Standards Handbook.

.9 UL 900-2015 - Standard for Air Filter Units.

.10 SMACNA 1966-2005 - HVAC Duct Construction Standards - Metal and Flexible.

1.4 **SUBMITTALS FOR REVIEW**

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide literature which indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, and electrical characteristics and connection requirements.

.2 Provide data of filter media, filter performance data, filter assembly, and filter frames.

.3 Provide fan curves with specified operating point clearly plotted.

.4 Submit sound power level data for both fan outlet and casing radiation at rated capacity.

.5 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

.3 Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Manufacturer's special installation requirements.

1.6 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials: Provide one (1) set for each unit of fan belts and filters.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 ISO 14000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience, who issues complete catalogue data on total product.

1.9 **DELIVERY, STORAGE, & PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

.3 Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.10 **ENVIRONMENTAL REQUIREMENTS**

.1 Ambient Conditions: Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

Part 2 - Products

2.1 **DEHUMIDIFIER - DESIGNATED DH-1**

.1 **General:**

.1 Dehumidifier shall be built to the level of quality as herein specified and to the description of the Unit Schedule. Dehumidifier shall be Engineered Air.

.2 Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded.

.3 Unless stated otherwise, Dehumidifier is to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close proximation to the intent of this specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as CETL, ETLUS, UL, CSA prior to shipment.

.4 Pre-wired units shall bear an approved label with all the necessary identification marks, electrical data.

.5 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.6 The Dehumidifier and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.

.2 **Unit Construction:**

.1 Unit casing shall be of minimum 18 gauge (1.3 mm) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.3 A solid 22 gauge (.85 mm) internal liner shall be provided throughout the unit interior and unit underside.

.4 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, electrical control panels, compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will only be acceptable for the plenum between the DX and condenser coils. The plenum shall be a minimum of 12".

.5 Units shall be provided with hinged access doors, with e-profile gasket, fully lined, and a minimum of two lever handles, operable from both sides for all units.

.6 All units shall be internally insulated with 1" (25 mm) thick 1-1/2 lb./cu.ft. (24 kg./cu.m.) density insulation.

.7 101/2 lb./cu.ft. (24 kg/cu.m.)insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400 mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.8 Cooling coil drain pans shall be fabricated of stainless steel and are an integral part of the floor paneling, a minimum of 2" (51 mm) deep, with welded corners. Drain pans shall extend a minimum of 6" (152 mm) downstream of coil face and be provided with a 1-1/2" (38 mm) S.S. M.P.T. drain connection. Drain pans must have a fast pan and be sloped and pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.

.3 **Fans:**

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

.2 All forward curved fan assemblies shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.

.3 Drives shall be adjustable on fans with motors 7-1/2 HP (5.6 kW) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.

.4 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.5 Provide single extended grease line from far side to access side bearing.

.6 Fan motors shall be ODP (open drip proof) Super-E high efficiency.

.7 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor that is welded to the structural frame of the unit. Use of separate bumpers or snubbers are not acceptable. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric with a sealed double locking fabric to metal connection. The isolators shall be neoprene-in-shear type for single 9" (230 mm) to 15" (380 mm) diameter forward curve fans.

.4 **Coils:**

.1 Coils shall be as manufactured by Engineered Air, constructed of copper tube, aluminum fin, and copper headers.

.2 Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

.3 Headers shall be outside the air-handling unit for maximum serviceability except for blow through applications where headers are internal. The non-headered end of the coil shall be fully concealed. Provide auxiliary drain pan complete with 1/2" (13 mm) MPT drain connection at headered end of cooling coils.

.4 Coils shall be removable from the unit at the header end, unless shown otherwise on the drawings. All water coils shall be equipped with a capped vent tapping at the top of the return header or connection, and a capped drain tapping at the bottom of the supply header or connection.

.5 Refrigerant evaporator type coils shall be equipped with distributors connected to the coil by copper tubes.

.5 **Filters:**

.1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.

.2 The filter modules shall be designed to slide out of the unit. Side removal 2" (50 mm) filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.

.3 2" (50 mm) Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fiber media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Permanent re-usable metal enclosing frame. The filter media shall have a minimum efficiency of 30-35% on ASHRAE Standard 52.1-92, and a minimum of MERV 8 per ASHRAE 52.2. Rated U.L. Class 2.

.4 Filter media shall meet UL Class 2 standards.

.6 **Mechanical Dehumidification:**

.1 Compressors shall be hermetic type, 3600 RPM, set on resilient neoprene mounts and complete with live voltage break internal overload protection and internal pressure relief valve. External crankcase heaters locked out during compressor operation.

.2 Packaged Dehumidifier:

.1 Packaged units shall be supplied with R-410a refrigerant.

.2 Condenser coils shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

.3 Condenser to sit within unit airstream, downstream of DX coil. No remote condenser.

.4 Water removal requirement is listed in the performance schedule.

.5 Controls for hermetic compressor units shall include compressor contactors, control circuit transformer, cooling relays, non-recycling pump down relays, ambient compressor lockout, manual reset high pressure controls and automatic reset low pressure controls. Provide optional compressor service valves for packaged units incorporating hermetic compressors

.6 Provide five minute anti-cycle timers.

.7 Provide hot gas bypass and suction accumulator on the compressor to maintain adequate suction pressure in the event of low loads.

.8 Provide separate compressor compartment complete with 1" (25 mm) 1-1/2 lb./cu.ft.(24 kg/cu.m.) acoustic insulation and hinged access doors and lever handles for full accessibility and serviceability.

.9 Refrigeration specialties such as solenoid valves, TX valves, etc., to be supplied and installed by equipment manufacturer.

.3 Dehumidification Control: Electro-Mechanical control shall have one-stage room control via a room mounted humidistat.

.7 **Factory Supplied Controls/Wiring:**

.1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors, and terminals for the connection of external control devices or relays.

.2 Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.

.3 Factory installed and wired non-fused disconnect switch in CEMA/NEMA 1.

.4 Automatic controls shall be housed in a control panel mounted in or on the Dehumidifier, which will meet that standard of the specific installation.

.5 Remote Panel - Provide a remote mounted control panel for the purpose of switching and visual indication of operations. Each panel to be NEMA 1 indoor rated and is to include the following items:

.1 Fan on/off switch

.2 Fan on/off light

.3 Clogged filter indication light

2.2 ENERGY RECOVERY VENTILATOR - DESIGNATED ERV-1

.1 General:

.1 Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.

.2 Substitution of any product other than that specified must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.

.3 Unless stated otherwise, air-handling units are to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close approximation to the intent of this specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired and factory certified by an approved testing agency such as ETL, UL, or CSA for the destination.

.4 All electrical circuits shall undergo a dielectric strength test and shall be factory tested and checked as to proper function.

.5 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifty (50) continuous years of proven production experience.

.6 Air Handling Units shall be as manufactured by Engineered Air and be base bid. Cost savings must be shown for alternate products, and it must be clearly indicated in all areas where the alternate products do not meet the specified product.

.2 Unit Construction:

.1 Unit casing shall be of minimum 18 ga (1.3 mm) satin coat galvanized sheet metal. Surfaces on indoor and outdoor units shall be cleaned with a degreasing solvent to remove oil and metal oxides. Outdoor units shall be primed with a two-part acid based etching primer. All unprotected metal and welds shall be factory coated.

.2 All exposed surfaces shall have a finish coat of alkyd enamel to all exposed surfaces with an ASTM B117 11 salt spray rating of 500 hrs.

.3 All walls, roofs, and floors shall be of formed construction with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.4 Provided a 22 ga (.85 mm) solid satin coat galvanized metal liner over insulated areas.

.5 Units shall be provided with access doors to the following components: fans, motors, filters, dampers and operators, access plenums, humidifiers/wet cells, electrical control panels and burner/compressor compartments. Access doors shall be as large as practical for easy access. Screwed wall panel access will not be acceptable for the above listed components.

.6 Units shall be provided with hinged access doors with e-profile gasket, fully lined, and a minimum of two lever handles.

.7 All units shall be internally insulated with 1" (25 mm) thick, 1 1/2 lb./ft.3 (24 kg/m3) density coated insulation.

.8 The coated insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 18" (450 mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent deterioration of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.9 Outdoor units shall be weatherproofed and equipped for installation outdoors. Units shall be fabricated to prevent the infiltration of rain and snow: louvers or hoods shall be provided on air intakes and exhaust openings. Rain gutters or diverters shall be installed over all access doors. All joints shall be caulked with a water resistant sealant. The roof joints shall be turned up 2" (51 mm) with three break interlocking design and the outer wall panels shall extend a minimum of 1/4" (6 mm) below the floor panel.

.10 Outdoor units over 16 ft. (4.9 m) wide, over 10 ft. (3.1 m) high, equipped with a sloped roof, or with unit split(s) shall be provided with a membrane roof to ensure prevention of infiltration of rain and snow through the top of the unit.

.11 Provide full perimeter roof mounting curb of heavy gauge sheet metal at a minimum of 16" high complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25 mm) upturn on inner perimeter to provide a complete seal against the elements. External insulation and flashing of the roof-mounting curb shall be provided by the roofing subcontractor.

.3 **Fans:**

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

.2 Single low pressure forward curved fans of 18" (457 mm) diameter or smaller shall be equipped with greaseable pillow block bearings supported on a rigid structural steel frame.

.3 Fan motor sheaves shall be adjustable with motors 7 1/2 HP (5.6 kW) and smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.

.4 Provide full section return air fan(s) as scheduled. The use of power exhaust propeller type arrangements will not be considered.

.5 Fan and motor sheaves shall be factory installed, fan balanced, and tested prior to shipment.

.6 Motor, fan bearings, and drive sheaves assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.7 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor that is welded to the structural frame of the unit. Use of separate bumpers or snubbers are not acceptable. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric with a sealed double locking fabric to metal connection. The isolators shall be neoprene-in-shear type for single 9" (230 mm) to 15" (380 mm) diameter forward curve fans.

.8 Provide single extended grease line from far side to access side bearing.

.9 Fan motors shall be ODP (open drip proof) high efficiency type.

.4 **Filters:**

.1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side of the unit as noted on the drawings.

.2 The filters shall be designed to slide out of the unit. Side removal filters shall slide into a formed metal track sealing against metal spacers at each end of the track.

.3 The filters shall be lift out from an access plenum upstream of the filters. Lift out filters shall fit into a horizontal track from which they are lifted up and out.

.4 Prefilter: 2" (50 mm) Extended Media (Pleated) Disposable Filters: Filters shall be extended surface pleated complete with 100% synthetic media that does not support microbial growth. Frame shall be a high wet strength beverage board with a cross member design that increases filter rigidity and prevent breaching. Frame shall be recyclable. Filters shall have an expanded metal support grid bonded to the air-exiting side of the filter to maintain pleat uniformity and prevent fluttering. Metal support grid shall be recyclable. The filters shall be MERV 8 per ASHRAE 52.2. and rated U.L. 900 Class II. A permanent re-usable metal enclosing frame shall be provided for side loaded applications.

.5 Final filter: 4" (100 mm) Extended Media (Pleated) Disposable Filters: Filters shall be mini pleat air filters complete with 100% synthetic media that does not support microbial growth. Frame shall be constructed with high impact plastic and impervious to moisture and high humidity. Media pack shall be adhered to plastic frame on all sides to prevent air by pass. Filters shall have a hot melt bead separator to maintain pleat pack stability and ensure consistent pleat spacing for optimum air flow. The filters shall be MERV 13 per ASHRAE 52.2 and rated U.L. 900 Class II. A permanent re-usable metal enclosing frame shall be provided for side loaded applications.

.5 **Dampers:**

.1 Dampers shall be extruded aluminum, low leak, insulated blade Tamco Series 9000.

.2 2-position actuators factory supplied and wired.

.6 **Factory Supplied Controls/Wiring:**

.1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors, and terminals for the connection of external control devices or relays.

.2 Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.

.3 Factory installed and wired non-fused disconnect switch in NEMA type 3R weatherproof configuration.

.4 Controls shall be housed in a control panel mounted in or on the unit that will meet the standard of the specific installation.

.7 **Thermal Storage Recovery (HRRF) BKM Reverse Flow:**

.1 System Description

.1 Units shall be supplied with cassette housing and interconnecting ducts between the heat sink and damper providing proper face velocity.

.2 System must utilize a regeneration reversing fresh air / exhaust air recovery methodology with a minimum 70 second cycle time.

.3 Thermal storage cartridges must meet or exceed a sensible temperature output effectiveness of 90% wintertime, 80% summertime (+/- 5% based on grains of moisture in exhaust air stream). To achieve performance, the thermal storage capacity (heat sink) must be no less than 105 lb (47.7 kg) for every 500 cfm (236 L/s) of capacity per side.

.4 The minimum thermal storage supply air temperature swing shall be 3°F (1.7°C) at all balanced exhaust/supply air flow rates accomplished with a maximum one damper cycle every 70 seconds. Any additional cycling within the same time frame is not acceptable.

.5 The maximum allowable cross contamination in a balanced air flow system shall be 4% return air.

.6 Cartridges must have a wintertime latent return effectiveness of 70% at standard air conditions up to -40°F (-40°C).

.7 The minimum 90% performance (+/-5%) must be based on cassette pressure drop and velocity of no more than 0.402" WC (100 Pa) of static pressure at 437 ft/min (2.22 m/s), respectively, with a balanced air flow rate between the exhaust/supply air streams.

.8 Any type of frost control, such as pre-heat or bypass, to achieve specified recovery performance is NOT acceptable.

.2 Damper Section:

.1 The thrust bearing shall be sealed; any additional maintenance is not required.

.2 EPDM rubber shall be used for the seals. Seals are to be attached without the use of adhesives for ease of maintenance and replacement.

.3 The damper blade shall be insulated, double walled, and single blade design.

.4 All unit sizes must utilize a pneumatic damper drive system as standard equipment or optional DC servo drive.

.3 Heat Transfer Cassettes:

.1 The thermal storage energy recovery system shall be pure aluminum plates of 1100 alloy. The structural frames and optional storm louvers shall be constructed of 304 stainless steel.

.2 The energy transfer cassettes shall be fabricated using 63 corrugated plates per module and have a minimum thickness of 0.0276" (0.701 mm) and a maximum thickness of 0.032" (0.813 mm) per plate. With a sensible energy recovery effective rate of 90% winter, 80% summer (+/- 5%) and latent recovery of up to 70% during cold winter conditions, the system shall not require freeze protection to -40°F (-40°C) under standard applications.

.3 Each individual cassette must weigh 105 lb (47.7 kg) and shall be sized to an air flow rate of 500 cfm (236 L/s) to achieve 90% effectiveness.

.4 All cassettes shall be cleanable with a pressure washer if required.

.4 Controls:

.1 An integral control panel shall be unit mounted.

.2 Damper operation with DC Servo shall include the following components:

.1 DC Servo-driven precision linear actuator

.2 Damper control timer with built-in economizer cycle

.3 Sealed from contamination

.4 Adjustable positioning

.5 On/off switch and building power connection block.

.6 PLC servo controller

.7 For outdoor applications, a thermostatically-controlled electric heater and vent fan is provided to keep the control cabinet heated/cooled for proper protection and operation of the controls

.8 For indoor applications, a thermostatically-controlled vent fan is provided when the control cabinet is installed in a conditioned space

Part 3 - Execution

3.1 **INSTALLATION - DEHUMIDIFIER**

.1 Support units per manufacturers recommendations complete with spring isolators.

.2 Provide components furnished as per manufacturer's literature.

.3 Provide all water piping so water circuits are serviceable, without having to dismantle excessive lengths of pipe.

.4 Provide drain valves to each coil.

.5 Provide certified wiring schematics to the electrical division for the equipment and controls.

.6 Provide all necessary control wiring as recommended by the manufacturer.

.7 Provide condensate traps in accordance with manufacturers recommendations.

.8 Submit start-up report to the Consultant

3.2 **INSTALLATION - ERV-1**

.1 **Examination:**

.1 Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.

.2 Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.

.3 Proceed with installation only after all unsatisfactory conditions have been corrected.

.2 **Installation:**

.1 Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.

.2 Install unit with clearances for service and maintenance.

.3 Install and mount unit onto manufacturers supplied roof curb complete with spring isolators

.3 **Connections:**

.1 In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.

.2 Duct installation and connection requirements are specified in Division 23 of this document.

.3 Electrical installation requirements are specified in Division 26 of this document.

.4 **Field Quality Control:** Contractor to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to Architect/Engineer in writing. Inspection must include a complete start-up checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM. Insert any other requirements here.

.5 **Start-Up Service:**

.1 Contractor to perform start-up service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage.

.2 Provide start-up report to the Consultant

.6 **Demonstration & Training:**

.1 Contractor to train owner's maintenance personnel to adjust, operate and maintain the entire Make-Up Air unit.

.2 Refer to Division 01 Sections for Closeout Procedures and Demonstration and Training.

END OF SECTION

Part 1 - General

1.1 **SECTION INCLUDES**

.1 Reheat Coils

.2 Unit heaters.

.3 Cabinet unit heaters.

1.2 **RELATED SECTIONS**

.1 Section 23 21 00 - Hydronic Piping.

.2 Section 23 21 16 - Hydronic Specialties

.3 Section 25 90 00 - Sequence of Operation.

.4 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections Installation of room thermostats Electrical supply to units.

1.3 **REFERENCES**

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 CSA (Canadian Standards Association).

.4 UL (Underwriters Laboratories Inc.).

1.4 **SUBMITTALS FOR REVIEW**

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide typical catalogue of information including arrangements.

.3 Shop Drawings:

.1 Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.

.2 Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

.3 Indicate mechanical and electrical service locations and requirements.

.4 Samples: Submit one (1) sample of each radiation cabinet detailed.

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Manufacturer's special installation requirements and recommendations.

1.6 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

.3 Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

.4 Record Documentation: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials: Provide two (2) sets of filters.

1.8 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.9 **REGULATORY REQUIREMENTS**

.1 Products Requiring Electrical Connection: Listed and classified by CSA UL and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

Part 2 - Products

2.1 **RE-HEAT COILS - DESIGNATED HC-1, HC-2 ETC.**

.1 Coils shall be 5/8" O.D. as manufactured by Engineered Air, constructed of Copper tube, aluminum fin, with sweat connection and 18 gauge galvanized casing.

.2 Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

.3 Coils shall be circuited to provide adequate tube velocities to meet design requirements. Internal turbulators are not acceptable.

.4 Multiple row coils shall be of staggered tube design circuited to optimize capacity with minimum pressure drop.

2.2 **UNIT HEATERS - DESIGNATED UH-1, UH-2, ETC.**

.1 Design is based on Ouellet

.2 Acceptable Products:

.1 Reznor
.2 Ouellet
.3 Modine

.3 Color: almond.

.4 Finish: polyester powder paint.

.5 Voltage: 208V, 3-phase.

.6 Construction:

.1 20-gauge steel.

.2 Adjustable louvers to direct air flow.

.3 High-limit temperature control with automatic reset.

.7 Fan:

.1 67 dBA

.2 Thermally-protected motor mounted in cold compartment.

.3 Fan delay purges heater of residual heat.

.8 Heating element: Finned steel (15 to 60 kW). Concentric disposition of heating elements.

.1 Control: Built-in thermostat.

.2 Horizontal mounting: Wall or ceiling using the supplied brackets which allow 360° rotation.

.3 Vertical mounting: 4 threaded rods 1/2 in. X 13 UNC.

.9 Warranty: 3-year warranty against defects.

2.3 **CABINET UNIT HEATERS - DESIGNATED CH-1, CH-2, ETC.**

.1 Design is based on Ouellet

.2 Acceptable Products:

.1 Reznor

.2 Ouellet

.3 Modine

.3 Color: white.

.4 Finish: polyester powder paint.

.5 Voltage: 120V, 1-phase.

.6 Construction:

.1 18-gauge steel.

.2 Bottom air outlet.

.3 High-limit temperature control with automatic reset.

.7 Fan:

.1 55 dBA

.2 Closed, factory lubricated motor.

.3 Fan delay purges heater of residual heat.

.8 Heating element: Durable tubular heating element with fins.

.9 Control: Built-in thermostat.

.10 Warranty: 3-year warranty against defects.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install to manufacturer's written instructions.

.2 Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage.

.3 **Protection:** Provide finished cabinet units with protective covers during balance of construction.

.4 **Unit Heaters:** Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

.5 **Cabinet Unit Heaters:** Install as indicated. Coordinate to assure correct recess size for recessed units.

3.2 **CLEANING**

.1 Section 01 74 11 - Cleaning: Cleaning installed work.

.2 After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

.3 Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials provided by manufacturer.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Control equipment.

.2 Software.

1.2 RELATED SECTIONS

.1 Divisions 21, 22, 23

.2 Section 25 90 00 - Sequence of Operation.

.3 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

.4 Division 27 - Communications

.5 Section 28 31 00 - Addressable Fire Alarm & Voice Communication Systems.

1.3 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC)

.3 NEMA 250 - Enclosures for Electrical Equipment (1000 Volt Maximum).

.4 NFPA 90A -Standard for Installation of Air Conditioning and Ventilating System.

.5 National Research Council Canada (NRCC), National Energy Code for Building.

.6 Region of Peel - Affordable Housing Design Guidelines and Standard for Apartment Buildings / for Townhouses.

.7 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE): ANSI/ASHRAE 135-, BACnet - Data Communication Protocol for Building Automation and Control Networks

.8 Consumer Electronics Association (CEA): CEA 709.1-2002, Control Network Protocol Specification.

.9 Canadian Standards Association (CSA): CSA C22.2 No. 45, CSA C22.2 No. 75, CSA C22.2 No. 83

1.4 SYSTEM DESCRIPTION

.1 **Basis of Design:**

.1 The basis of design for CoM EMCS Upgrades incorporates a dedicated CoM Enterprise server (or virtual server) complete with operating system, all necessary software tools, and an EMCS Enterprise Server Software (ESS) package that has a fully open and accessible licensing structure. The design also includes a second back-up server for storage of all system database parameters including back-up of all BAS Vendor specific field controller programming, trend data, and color graphics. Both servers are located in a CoM designated server room and be connected to the CoM wide area network ("WAN") for communication to multiple sites and multiple EMCS products.

.2 The new system architecture utilizes Tridium Niagara Framework N4 as the pre-selected EMCS ESS package. Vendors shall coordinate with the CoM prior to the start of any project to determine the current Revision of Software in use and to be applied to SRPDC.

.3 The anticipated EMCS upgrade work involved at each facility including new construction projects shall comprise the supply and installation of a new supervisory remote digital controller (SRPDC), BAS Sub-Network Controllers (SNC), remote programable digital controllers (RPDC), terminal equipment controllers (TEC) and connection to other original equipment manufacturer application specific controllers (OEMASC) over EMCS vendor supplied communication network(s).

.4 The EMCS vendor supplied SRPDC shall be a Tridium Niagara JACE 8000 Series controllers. EMCS vendor supplied SNC shall be Tridium Niagara Edge controller(s) connected to EMCS/BAS vendor specific RPDC, TEC, and OEMASC over a field network utilizing BAC-net communication protocol in an open, able to exchange information system. (Where direction has been provided from CoM to connect to existing LON based controllers, LON Communication may be used).

.5 All SRPDC, RPDC, TEC, EMCS Routers/Switches, etc. to be in lockable NEMA rated enclosures. If in doubt, seek clarification from CoM before submitting a quotation on any project.

.6 All graphics, EMCS programming, trend data, security settings, access level priorities, etc. shall be uploaded by the EMCS vendor(s) and stored on the Server for each project (without need for the involvement of others). This shall be repeated at the start of commissioning and again upon completion of deficiency clean-up and as-builts. Remote access will be provided in accordance with current City of Mississauga IT policies, procedures, and processes.

.7 City of Mississauga Pre-Qualified EMCS vendors and products are:

Facio Corporation	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller. Distech Eclypse BacNet IP series controllers
Automated Controls	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller
Airon HVAC	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller
Ainsworth	Schneider Smart X BacNet IP series, with Niagara module (programmable via Niagara Workbench)
Accu-temp systems	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller
Modern Niagara	Distech - Eclypse - Bacnet IP series controllers

.2 **Original Equipment Manufacturer Application Specific Controllers (OEMASC):**

.1 The use of dedicated equipment controls supplied by others shall be pre-approved by the City of Mississauga Facilities Management.

.2 All equipment of this nature shall come with a BAC-net compliant communications interface communicating via BAC-net IP (or approved equivalent that is supported by the Pre-Qualified DDC Vendor Hardware interface modules - i.e. LON/Modbus/etc.). The use of Non-BAC-net communication protocols shall only be considered if Bac-Net IP is not available.

.3 Connection to the OEM supplied controls shall be via a dedicated Sub-Net communication BUS running from the SNC to the OEMASC's.

.4 Building Controllers, are to be stand-alone microprocessor-based controllers that handle the staging, sequencing, control and coordination of specific HVAC equipment and related systems components (Example Chillers/Boilers AHU's/ Other) or a dedicated application specific control system (example, Lighting Control, Power Monitoring, etc.). This provides a sole source of responsibility for the equipment's performance to avoid damage to the equipment, to increase safety, and to increase vendor and manufacturer responsiveness during problem solving.

.5 All OEMASC shall be a fully BAC-net compliant devices in order to facilitate interoperability between OEM electrical/mechanical sub-systems and BAC-net EMCS. The use of a gateway/protocol translator shall not be allowed.

.6 The OEM shall provide any software or hardware required to access or modify any electrical/mechanical subsystems *i.e. RTUs, VSDs, Chillers, Lighting controls and /or Electrical Monitoring & metering.

.7 All submittals for both EMCS and OEM supplied equipment shall identify the interface between EMCS and OEM supplied controller including available points to read/write between systems.

.8 Set up, testing and commissioning of the interface between OEMASC and the EMCS control system shall be carried out with both parties (OEM Programmer and EMCS Programmer) present on site to ensure the proper communication set up and establishing control priority levels and parameters. The cost of these services shall be included in the price from both vendors.

.3 Software License Agreement:

.1 It shall be possible to insure the Owner can prevent unauthorized partners from accessing the system for engineering changes.

.2 Software licensing shall have the freedom to individually manage authorized parties and independent parties.

.3 The Owner shall accept the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

.4 Software licensing for the Tridium Controller (JACE) shall be owned by the City of Mississauga (CoM).

.4 Provide a fully integrated Building Automation System (BAS) incorporating Direct Digital Control (DDC) Energy Management, monitoring and control of HVAC equipment, and room control. The Building Automation System shall be fully integrated to provide the end users with full control, monitoring and management functions, based on a common computer operating system and operating procedures. The BAS shall consist of the following elements:

.1 A combination of one or more Network Controllers within the facility. The Network Controllers shall connect to the owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each Network Controller shall communicate to BACnet programmable plant or application specific controllers. Each Network Controller shall be provided with BACnet IP licensed driver and shall be capable of providing all the required data contained within the Network Controller and the connected plant controllers to third party supervisory servers via standard BACnet protocols.

.2 Microprocessor-based BACnet compliant primary plant controllers and BACnet certified intelligent Application Specific Controllers (ASC) interfacing directly with sensors, actuators and environmental delivery systems (i.e. HVAC equipment such as chillers and boilers, room climate controls, lighting systems, electrical systems, etc.).

.3 Electronic sensors and final control elements including valves and actuators.

.4 A BACnet open communication network to allow data exchange between primary controllers and centrals.

.5 A personal computer (PC)-based central, with web based graphical user interface functioning as the primary operator interface to the BAS.

.6 All system components shall be fault tolerant.

.7 Provide satisfactory operation without damage at 110% and 85% of rated voltage and at + 3 Hz variation of line frequency.

.8 Provide static, transient and short circuit protection on all inputs and outputs.

.9 Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus-connected devices shall be transformer coupled or equivalent so that any single device failure shall not disrupt or halt bus communication.

.10 All real time clocks and data file RAM should be capacitor-backed or battery-backed. The minimum life span for the battery shall be 30 days.

.11 The BAS must have consistent equipment type naming for all BAS points.

.12 The BAS must use unique tag for all BAS points. Supply and install lamacoid plates (black and white letters) for all equipment with same width as ceiling grid mounted on ceiling. Every tag will have the entire point name which includes the controller where it's coming from.

.13 Vendor is responsible for verifying that connected site equipment (i.e. HVAC, lighting, etc.) is operational before its connection to BAS. Consultant must verify that equipment testing has occurred prior to BAS installation and at the completion of BAS installation.

.5 BAS Equipment Type:

.1 Equipment shall be native BACnet ANSI/ASHRAE Standards 135-2008 (the most current version of the Standard if the 2008 Standard is superseded) including IP Addendum.

.2 All BACnet controllers must have a BTL compliance statement.

.6 Controller Level Equipment Requirements:

.1 All BACnet controllers must have a BTL compliance statement, BIBB and PIC information supplied for review by Agency before the project starts.

.2 BACnet controllers shall be compatible to directly communicate with each other.

.7 Supervisory Level Communication Protocol: Main network controller communication protocol shall be BACnet/IP and MS/TP (Master Slave Token Passing) (Ethernet 10/100bT LAN/WAN).

.8 Controller level "Subnetwork" Communication Protocol:

.1 Sub-network controller communication protocol shall be BACnet and MS/TP.

.2 Shall have installed hardware and memory for expansion of a minimum of 10% of each input/output point type.

.3 Include all licensing and firmware upgrades required to edit, create, and modify graphics, programming and configuration.

.4 All software to be installed with the latest version or as specified by the owner.

.5 All software should be the latest version at any given time. Updates of the program should be included during the warranty period. At the end of the warranty period the most recent firmware will be installed.

.9 Functional & Security:

.1 Controller Level Equipment Requirements: Shall store alarming, event history, and user logs, for a minimum of 6 months, without operator intervention on front controller.

.2 Controller Level Equipment Requirements: All thermostats will have a gasket behind the base plate to prevent airflow from affecting temperature reading.

.3 Hardware Security Features: Some application level controllers will be equipped with protective covers to avoid damage.

.4 Trending points to include all input, all output, all calculated variables, all set points, all PID (Proportional Integral Derivative) loops or as per Agent/Owner requirements.

.5 Controllers and associated hardware and software: operate in conditions of 0 degrees Celsius to 44 degrees Celsius and 20 % to 90 % non-condensing Relative Humidity.

.6 All Fans and or Ex-Fans shall have a Binary or Analog Point (Amperes) wired to the BAS for monitoring purposes.

.7 Garage Exhaust Gas Monitoring and Ventilation System: The BAS shall monitor the actual gas levels. The communication protocol shall only be BACnet IP and or MS/TP.

.10 **BAS Features:**

.1 BAS Sequence of operations to be completed as per design and as per as built.

.2 BAS Sequence of operations documentation to be provided for each system.

.3 BAS Scheduling to be completed as per design.

.4 BAS Setpoints and upper/lower limit temperature ranges to be completed as per design.

.5 BAS equipment operation to respond to Demand Response i.e. "Smog Alert" algorithm and other demand response measures. Includes capability for receiving "Smog Alerts" and "energy information", and acting based on sequence of operation.

.6 Schedules will include exception days and periods, and holiday schedules programmable one year in advance.

.7 Schedules will include separate optimum stop and or start capability.

.8 Design - BAS Web Access

.9 Co-ordinate email remote alarming with Agency. Critical alarm notifications for the BAS routes to the customer service centre after hours. Must have the capability to send alarm to multiple destinations.

.11 **BAS Administrative Requirements: (PRPS Specific)**

.1 Devices installed in user occupied space shall not exceed Noise Criteria (NC) of 30. Noise generated by any device must not be detectable above space ambient conditions.

.2 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.

.3 Perform On/Off digital control of connected points, including resulting required states generated through programmable logic output.

.4 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.

.5 Control of systems as described in sequence of operations.

.6 Execution of optimization routines as listed in this section.

.12 **City of Mississauga Energy Management System Guideline**

.1 In order to maintain consistency in both the design and operation of BAS control systems, the CoM has developed a list of Typical Points and Standard Sequence of Operation to be applied to each typical system.

.2 All project specific sequences are to be submitted to the CoM for review and approval prior to Tenders Final schedules, set-points, limits, dead bands, etc shall be determined during commissioning and then documented in the as-built drawings and final project close out documentation.

.3 The City of Mississauga's Pre-Qualified EMCS Vendors shall be responsible to make note of any deviations between the Project Specific Specifications and City of Mississauga Master Specifications for EMCS Upgrades (Current Revision). Such deviations shall be brought to the attention of the City of Mississauga project manager prior to tender closing.

1.5 **SUBMITTALS**

.1 Submit the following Items 1.5.2 to 1.2.3 as shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 **System configuration schematics:**

.1 Provide drawing(s) of all components of monitoring and control system. Identify all central and field processor units, communications links, etc. by label and location. End devices need not be shown. Schematics must be clearly drawn and well arranged.

.2 Show all electric interlocks and controlling devices provided by Division 26.

.3 Show layout of terminal strips of all processor units and field interface devices

.4 On completion of work, submit schematics and as-builts.

.3 **Equipment description:**

.1 Provide technical specifications of all equipment employed in the system, including sensors and actuated devices. Include manufacturer, model, input requirements, accuracy and calibration data, capacity, environmental limitations, parts lists, etc. Identify by point label.

.2 Provide a points list describing type, function and label of all DDC control points. The label for each point shall be common to all documentation, e.g. system schematics, as-builts, field tags.

.3 Include all hardware and virtual point to be identified in the points list, and will have the capability of being trended, alarmed, and controlled. List of monitoring points, trends and alarms will be completed when the system is programmed.

.4 The BAS points list to be approved by CoM. Main equipment, minimum point types to be provided by CoM for BAS design.

.5 Provide all points with "real time" feedback of actual operations.

.6 Provide all points with capability to be monitored, trended, controlled and alarmed.

.7 Connect all HVAC and lighting equipment to BAS. In the case of private offices, small locations and storage areas, 24/7 operations or remote small buildings use motion detectors to control lighting.

.8 Provide valve and damper schedule indicating size, configuration, capacity and location. If size varies greater than 10% from specification, obtain approval of Consultant.

.9 Provide detail wiring diagrams to Consultant for review within three months after award of Contract. Wiring diagrams shall include equipment wiring.

1.6 **TRAINING**

.1 The supplier shall offer training in the factory and on the site. This training shall be given by the Vendor, during the start-up of the new control system and before the provisional acceptance.

.2 Provide a list of the proposed trainer. Trainer must be a competent instructor thoroughly familiar with specific aspects of EMCS installed in facility. Consultant and/or Owner reserves right to approve instructors.

.3 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed. Training to be project-specific.

.4 Submit training documentation for review 30 days minimum before training. Documentation shall include an agenda for each training day, objectives, a synopsis of each lesson, and instructor's background and project specific

.5 The training documentation can be submitted at the same time as the project's Controls System Operators Manual.

.6 Upon request, provide a list of the courses available and the associated costs.

.7 Training on site shall be based on instruction for 3 different user groups, with 2 sessions per group and 4 hours of training per session. Each user groups will require a custom user-group specific level of training based on their designated user access level and functional interaction with the EMCS.

.8 Training to be provided for each EMCS installation (unless otherwise noted in the tender documents).

.9 Training shall be delivered by a qualified representative of the supplier who was directly involved in the installation of the system for which the operators are being trained.

.10 Prior to the start of training the Vendor shall ensure the manuals are submitted, approved, and available to hand out to the trainees before the start of the first training session.

.11 Commissioning and demonstration of the system are an independent task and shall not be considered as part of the training on site.

.12 Upon completion of the training, each trainee should fully understand the project's DDC system fundamentals. The TRAINING ON SITE shall be given in two (2) parts, but not limited, as follows:

.13 **Part One**:

.1 System Overview and Fundamentals

.1 Review of As-Built documentation including

.2 Overview of systems controlled and related components.

.3 Overview of project's list of points and objects.

.4 Overview of project's device network communication architecture.

.5 Overview or project's specified sequence of control for each system.

.6 Overview of Alarms Types, Alarm Limits, and Routing.

.7 Overview Trending Capabilities and Data Storage

.14 **Part Two:**

.1 System Access and Operation

.1 The second session of training shall be conducted at the Local Operators Workstation Connected to the EMCS in the field via the Enterprise Server. Upon completion of the session, each trainee should fully understand the project's EMCS site specific installed operation.

.2 The training session shall include the following:

.1 A walk-through tour of the mechanical systems and the installed BAS components.

.2 A discussion of the components and functions at each BAS panel.

.3 Logging-in and navigating at operator interface type.

.4 Modifying set-points.

.5 Creating, editing, and viewing trends.

.6 Creating, editing, and viewing alarms.

.7 Creating, editing, and viewing operating schedules and events.

.8 Trouble shooting hardware errors.

1.7 SYSTEM ARCHITECTURE

.1 Provide a complete Building Automation System (BAS), which uses a communication architecture consisting of at least two tiers. Each tier will utilize local area networks with totally open protocols based on industry leading standards.

.2 The first tier of the BAS network (level 1) will be based on Ethernet (ISO 8802-3/IEEE 802-3) communications, providing a high-speed local area network for reliable peer-to-peer communications. Future connected systems will have compatibility specifications to provide communication with the first tier LAN. The operator workstations will also be supported on the high speed LAN level 1.

.3 The BAS must be based on Open Systems. The BAS shall employ the following standards:

.1 BACnet protocol for communication between controllers. BACnet protocol implementation shall adhere to the ANSI/ASHRAE Standard 135. Communications between BACnet devices shall be 76.8 kbps over approved twisted shielded pair cabling utilizing Master/Slave Toke Passing BACnet protocol. BACnet defines a comprehensive set of object types and application services for communication requirements among all levels of control in a distributed, hierarchical Building Automation System. BACnet is intended to provide a single, uniform standard for the BAS to provide the required interoperability.

.4 The intent of this specification is to provide a complete distributed direct digital control (DDC) system. The controllers shall be selected so that each mechanical system operation is completely standalone. Each system operation, such as central chillers, air handling units, packaged cooling units or terminal devices such as heat pumps and fan coil units, will be controlled by a single standalone DDC controller.

.5 All hardware points (input and output) must have installed capability of being manually overridden at the front end or at the local controller.

.6 Integrate hardware and software override operations, including override panels, as outlined in points list. To be approved by CoM.

.7 Provide disaster recovery plan that will allow systems to remain operational in case of BAS failure. To be reviewed during submittal review.

1.8 **MAINTENANCE DATA & SERVICE**

.1 Provide maintenance data for incorporation into maintenance manual.

.2 Provide on-line maintenance supervision via VPN internet from the time of system start-up until one year from system acceptance, including the arrangements for and maintenance of the telephone service for this purpose.

1.9 **INTEGRATION WITH THIRD PARTY MANUFACTURER'S EQUIPMENT**

.1 Monitor and control the equipment as described in the point's list, schematics, sequence's of operation and respective equipment specification. The BAS System Designer must provide control system overlay of the points specified. Points inputs and outputs from BAS software features such as: Control Algorithms, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, Dial-Up and Local Area Network Communications, as mentioned in the specification. The BAS System Designer be able to integrate to third party integral controllers using the following standard open protocols:

.1 BACnet MSTP

.2 BACnet IP

.3 MODbus RS232

.4 MODbus TCP

.5 LON FTT-10-A

.6 LON IP

.2 When third party equipment is specified to have standalone controls integrated into the BAS, the third party equipment manufacturer shall be responsible to provide all required integral functionality to control their respective equipment in standalone fashion based on the sequence of operation and the required safe operation of their equipment. In addition, all required interface points for monitoring or commanding (read / write) as per the sequence of operation must be set up in the controller by the third party manufacturer ready for export once connected to the BAS via one of the above protocols.

Part 2 - Products

2.1 **GENERAL**

.1 The Specification shall be read as a whole by all parties concerned. Sectioning of the Specification is for convenience. Each section may contain more or less than the completed Work of any trade. The BAS System Designer is solely responsible to understand the scope of Work, and make clear to Subcontractors the extent of their Work in this section.

2.2 **NETWORK**

.1 The Local Area Network (LAN) shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Controllers, user workstations and, if specified, a local server.

.2 Local area network minimum physical and media access requirements:

.1 Ethernet; IEEE standard 802.3

.2 Cable; 100 Base-T, UTP-8 wire, category 5

.3 Minimum throughput; 100 Mbps.

2.3 **NETWORK ACCESS**

.1 **Remote Access:**

.1 For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

.2 The Operator Workstation hardware and Network Controllers shall be capable of interfacing to an IEEE 802.3 Standard Local Area Network (LAN).

2.4 **OPERATOR WORKSTATION**

.1 The operator workstation shall meet the following platform requirements:

.1 Processor: Intel® Xeon® CPU E5-2640 x64 (or better), compatible with dual- and quad-core processors

.2 Operating System: Windows 10, 64-bit Windows 8.1 Enterprise, 2012 R2 Standard, RHEL-7

.3 Memory: 1 GB minimum, 4 GB or more recommended for larger systems

.4 Hard Drive: 4 GB minimum, more recommended depending on archiving Requirements

.5 Display: Video card and monitor capable of displaying 1024 x 768 pixel resolution or greater

.6 Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector)

.7 Connectivity: Full-time high-speed ISP connection recommended for remote site access (i.e., T1, ADSL, cable modem) and IPv6 compliant

.8 Connection to the BAS network shall be via an Ethernet network interface card, 10 Mbps

.9 Provide an uninterruptible power supply and batteries for 30 minutes back up.

.10 The Operators Workstation (OWS) PC shall be located in Admin Office 024. A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 8 PPM print speed minimum.

.2 Storage and Memory: Logging capability/ storage for 5 years on operator workstation on every point (hardware and virtual for temperature, energy history, OAT) without operator intervention.

2.5 **SUPERVISORY INTERFACE SOFTWARE (SIS)**

.1 **Operating System:**

.1 The (SIS) shall run on Microsoft Windows 2016, and as a minimum meet the requirements of Item 2.4 Operator's Workstation.

.2 The SIS shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification. At a minimum, the SIS platform shall utilize HTML5 and shall provide the following functions and features:

.1 Provide centralized system management

.2 Support an unlimited number of users over the Internet / intranet with a standard Web browser

.3 Quickly navigate to individual buildings using tags to diagnose problems

.4 Provide a means to compare data between buildings

.5 Export system data to external databases

.6 Integrate BAS to other enterprise applications etc. through optional enterprise-level data archival using SQL, MySQL or Oracle databases and HTTP/HTML/XML, CSV or text formats

.7 Maintains an "Audit Trail" of database changes, database storage and backup, global time functions, calendar, central scheduling, control and energy management routines

.8 Utilize a single software tool to program network controllers and the SIS

.9 Remotely back up network controller applications to the SIS

.10 Batch provisioning of network controller firmware upgrades from the SIS

.11 Provide robust built-in analytic capabilities supported by standard Niagara components and visualizations

.12 Compatibility with Niagara Analytics 2.0, adding data source, functional and mathematical programming blocks to enable sophisticated analytic algorithms

.13 Integrate to other applications, such as work order management, analytics

.14 The BAS shall store alarming, event history, etc. automatically for a minimum of 5 years, without operator intervention. Stored data to be dumped onto a hard drive after 5 years.

.3 IT Requirements:

.1 IP address to be obtained through the CoM.

.2 Must use the latest version of HTML 5 software.

.3 Co-ordination of other IT requirements must be considered as outlined in Region of Peel Information System Technology Services (ISTS) Guidelines.

.4 Supervisory Level Software shall be located at the enterprise level on the Region of Peel Network.

.4 Real-Time Displays. The SIS, shall at a minimum, support the following graphical features and functions:

.1 Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the SIS shall support the use of scanned pictures.

.2 Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.

.3 Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.

.4 Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.

.5 Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

.6 Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.

.7 Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

.8 Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

.5 BAS Visual Graphics:

.1 For consistency across all programs/stakeholder groups to use as a guideline for BAS Graphics. BAS Graphics should include: site plans, floor plans with zoned equipment boundaries. Floor plans with six programmable colour coded levels to indicate the difference between space, temperature and set point. This guideline to set categories for alarm notifications. Used for visual alarms/notification. Not required for satellite stations and active response bays.

.2 Require a webpage of network architecture schematic. Also provide a PDF of the architectures.

.3 Requires a webpage of each system connected to the BAS. The sequence of operations for each system should be provided in the BAS in an editable format such as MS Word or Notepad.

.4 The webpages of each system must have a consistent layout. Follow the existing CoM Energy Management Controls System guideline.

.5 The BAS must have consistent display icons.

.6 System Configuration: At a minimum, the SIS shall permit the operator to perform the following tasks, with proper password access:

.1 Create, delete or modify control strategies.

.2 Add/delete objects to the system.

.3 Tune control loops through the adjustment of control loop parameters.

.4 Enable or disable control strategies.

.5 Generate hard copy records or control strategies on a printer.

.6 Select points to be alarmable and define the alarm state.

.7 Select points to be trended over a period of time and initiate the recording of values automatically.

.7 On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

.8 Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. The SIS shall utilize Role-Based Access Control (RBAC), making user permissions easy to configure and less error-prone. If required, system security access shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format. The SIS shall follow industry best practices for cyber security, with support for features such as strong hashed passwords, TLSv1for secure communications and certificate management tools for authentication. The SIS shall be able to be integrated with existing enterprise identity and access management systems, such as LDAP and Kerberos.

.9 System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

.10 Alarm Console:

.1 The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.

.2 When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

.3 The BAS shall be capable of filtering alarms based on urgency and time schedules and creating descriptive emails identifying both the alarm and the required response

.11 Network Communication: The SIS shall continue to update its database with real time information from the network controllers. The information shall be organized so that all required the data from all the controllers can be accessed without having to switch addresses, or manually have to call up other web servers on the network. When accessed through a web browser client, all the controllers shall be available and the entire project shall be presented from the SIS web server.

.12 Analytics: The SIS shall have a provision for additional license add-ons for up to 1000 analytic points

.13 BAS Access:

.1 Levels of Access: Include administrative process for full editing, creating, and modifying abilities. Permissions structure for users; Administrator- Full access, Operator- creating and modifying capabilities, dial out capability and Users - Read only access. The CoM must be provided the ability to create profiles or roles to operate the system. All default passwords and super administrator passwords must be provided to the CoM.

.2 The BAS must include operator access for customized selected capabilities for users.

.3 Include read only access to observe the BAS webpage, dial out capability via email to mobile devices for alarms and monitoring and operations.

.4 The BAS must allow the assignment of different login/passwords to unique users.

.5 The BAS must include hardware and software tools (i.e. license) to edit, create, and modify graphics, programming and configuration.

2.6 **NETWORK CONTROLLER HARDWARE & SOFTWARE**

.1 Network Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the Network Controller. It shall be capable of executing application control programs to provide:

.1 Calendar functions

.2 Scheduling

.3 Trending

.4 Alarm monitoring and routing

.5 Integration of LonWorks controller data, BACnet controller data and MODbus controller data plus an array of proprietary controller data via an expanded offering of third party drivers

.6 Network Management functions for all LonWorks, BACnet and MODbus based devices plus an array of proprietary devices via an expanded offering of third party drivers

.2 The Network Controller must provide the following hardware features as a minimum:

.1 TI AM3352: 1000MHz ARM® Cortex™-A8

.2 1GB DDR3 SDRAM

.3 Removable micro-SD card with 4GB flash total storage/2GB user storage

.4 Wi-Fi (Client or WAP):

.1 IEEE802.11a/b/g/n

.2 IEEE802.11n HT20 @ 2.4GHz

.3 IEEE802.11n HT20/HT40 @ 5GHz

.4 Configurable radio (Off, WAP, or Client)

.5 WPAPSK/WPA2PSK supported

.5 USB type A connector for back-up and restore support

.6 (2) isolated RS-485 with selectable bias and termination

.7 (2) 10/100MB Ethernet ports

.8 Secure boot

.9 Supply requirements: 24V AC rated at 24 VA minimum, or 24V DC rated at 1A (24W) minimum

.10 Runs Niagara AX: 3.8u1 and later

.11 Runs Niagara 4: 4.6 and later

.12 Niagara Analytics 2.0

.13 Real-time clock

.14 Batteryless

.15 The Network Controller must be capable of operation over a temperature range of -20 deg. C to 60 deg. C

.16 The Network Controller must be capable of withstanding storage temperatures of between -40 deg. and 85 deg. C

.17 The Network Controller must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

.18 The network controller shall have the hardware capacity to support up to 200 devices and/or a 10,000 point core. Partitioned scalability shall be provided through licensed bundles of devices and point cores up to the maximum capacity

.19 The network controller shall incorporate a modular design in order to support the following additional I/O's:

.1 RS-485 - 16 point I/O module - 16

.2 RS-485 - 34 Point I/O module - 8

.20 The network controller shall incorporate a modular design in order to support the following additional connection ports:

.1 LON FTT10A ports - 4

.2 RS-232 ports - 4

.3 2 X RS-485 ports - 2

.3 The Network Controller shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the Network Controller shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

.4 The Network Controller shall support standard Web browser access via the Intranet/Internet.

.5 Event Alarm Notification and actions shall model the SIS features and at a minimum provide the following functionality

.1 The Network Controller shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

.2 The Network Controller shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.

.3 Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:

.1 To alarm

.2 Return to normal

.3 To fault

.4 Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.

.5 Provide timed (schedule) routing of alarms by class, object, group, or node.

.6 Password control: Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values.

.6 Control equipment and network failures shall be treated as alarms and annunciated.

.7 Alarms shall be annunciated in any of the following manners as defined by the user:

.1 Screen message text

.2 Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

.1 Day of week

.2 Time of day

.3 Recipient

.3 Graphic with flashing alarm object(s)

.4 Printed message, routed directly to a dedicated alarm printer

.8 The following shall be recorded by the Network Controller for each alarm (at a minimum):

.1 Time and date

.2 Location (building, floor, zone, office number, etc.)

.3 Equipment (air handler #, accessway, etc.)

.4 Acknowledge time, date, and user who issued acknowledgement.

.5 Number of occurrences since last acknowledgement.

.9 Alarm actions may be initiated by user defined programmable objects created for that purpose.

.10 Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

.11 A log of all alarms shall be maintained by the Network Controller and/or a server (if configured in the system) and shall be available for review by the user.

.12 Provide a "query" feature to allow review of specific alarms by user defined parameters.

.13 A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

.14 An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.7 DATA COLLECTION & STORAGE

.1 The Network Controller shall have the ability to collect data for any property of any object and store this data for future use.

.2 The data collection shall be performed by log objects, resident in the Network Controller that shall model the features of the SIS and have at a minimum, the following configurable properties:

.1 Designating the log as interval or deviation.

.2 For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.

.3 For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.

.4 For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.

.5 Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

.3 All log data shall be stored in a relational database in the Network Controller and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.

.4 All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

.5 All log data shall be available to the user in the following data formats:

.1 HTML

.2 XML

.3 Plain Text

.4 Comma or tab separated values

.6 Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

.7 The Network shall have the ability to archive its log data either locally (to itself), or remotely to a server or other Network Controller on the network. Provide the ability to configure the following archiving properties, at a minimum:

.1 Archive on time of day

.2 Archive on user-defined number of data stores in the log (buffer size)

.3 Archive when log has reached its user-defined capacity of data stores

.4 Provide ability to clear logs once archived

.8 Hardware Security Features: All application level controllers will be equipped with unique logins and passwords.

.9 Storage and Memory: Memory must be installed to execute trending of each hardware point and virtual points simultaneously as indicated in the points list.

.10 Storage and Memory: Expected controllers trend intervals is 400 samples at an interval of 15 minutes for each point (i.e. 4 days of data for full capacity) with automatic transfer when reaches full capacity.

2.8 **AUDIT LOG**

.1 Provide and maintain an Audit Log that tracks all activities performed on the Network Controller. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the Network Controller), to another Network Controller on the network, or to a server. for each log entry, provide the following data:

.1 Time and date

.2 User ID

.3 Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.9 **DATABASE BACK UP & STORAGE**

.1 The Network Controller shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

.2 Copies of the current database and, at the most recently saved database shall be stored in the Network Controller. The age of the most recently saved database is dependent on the user-defined database save interval.

.3 The Network Controller database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.10 **INTEROPERABLE DIGITAL CONTROLLERS (IDC):**

.1 Provide BAS Controllers that conform to either ANSI/ASHRAE Standard 135, BACnet. Controllers using proprietary protocols or protocols other than BACnet are unacceptable. Provide a network of stand-alone, distributed direct digital controllers that operate on either or both of the following protocols using the specified physical layers:

.1 ANSI/ASHRAE Standard 135 BACnet Master/Slave Token Passing (MS/TP) at 76.8 kbps

.2 This division contractor shall provide all programming, documentation and programming tools necessary to set up and configure the supplied devices per the specified sequences of operation.

.3 The Network Controller will provide all scheduling, alarming, trending, and network management for the IDC.

.4 All IDC's shall be fully application programmable. Controllers offering application selection only (non-programmable) shall be acceptable for specific VAV, VVT applications. All control sequences within or programmed into the IDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

.5 This division contractor supplying the IDC's shall provide documentation for each device, with the following information at a minimum:

.1 Support documentation providing BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) or BACnet Advanced Application Controller (B-AAC)

.6 The supplier of any programmable IDC shall provide one copy of the manufacturer's programming tool, with documentation, to the owner. The manufacturer's programming tool must be the same standard software tool for all controllers, the same software programming tool must be able to program both the Network Controller and IDC.

2.11 **CONTROLLED DEVICES & SENSORS**

.1 **Automatic Control Dampers:**

.1 Supply control dampers with a leakage rate of less than 3 cfm./sq. ft. at 1" static pressure. Use opposed blade type dampers for modulating service. Dampers for two position service, face and bypass and mixing may be parallel blade type. Dampers on outside walls and roof shall be insulated dampers equal to TAMCO.

.2 Construct aluminum airfoil blades of minimum 12 gauge extruded aluminum. Blades to be 6" wide single air foil design. Construct damper frames of extruded aluminum channel with grooved inserts for vinyl seals. Standard frames are 2" x 4" x 5/8" on linkage side, and 1" x 4" x 1" on the other sides.

.3 Provide 7/8" hexagon extruded aluminum pivot rods that interlock into the blade section. Bearings to be double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.

.4 Design the bearing to prevent metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linkage. Blade linkage hardware is to be installed in a frame out of the air stream. All hardware to be made of non-corrosive reinforced material or cadmium plated steel.

.5 Supply overlapping damper seals that minimize air leakage. Insulate all dampers in direct contact with outside air with 7/8" thick polyurethane foam with R factor of 5.0 per inch. Blade construction must provide a 100% thermal break. Include frame with polystyrene, R factor of 5.0 per inch.

.6 Maximum allowable damper blade length is 40" per section. Provide dampers greater than 2 sections wide with a jackshaft.

.7 Where indicated on drawings, dampers shall be insulated type equal to Tamco series 9000.

.8 Acceptable damper manufacturers are: TAMCO, RUSKIN, NAILOR

.2 **Automatic Control Valves:**

.1 Control valve pressure ratings must suit the piping requirements as listed under other sections.

.2 Size the valves for flows in accordance with the following permissible pressure drops:

.1 Hot water coil valves - 1 psig

.3 All characteristics and pressure ratings of control valves shall be suitable to the required application, and the hydronic loops in which they are installed. Refer to pump schedules and drawings for details of hydronic heads. Valves shall be capable of bubble-tight shut-off against the total system differential pressure (i.e. Pump shut-off head at expansion tank set point).

.4 Straight through water valves shall be single seated with equal percentage flow characteristics. Combined butterfly valves, or combined eccentric plug valves shall be linear for each port giving constant total flow.

.5 All valves, except for radiation, terminal reheat and fan coil valves 1" NPT or less, shall have stainless steel stems and spring loaded Teflon cone packing. Radiation, terminal reheat, and fan coil valves 1" NPT or less shall utilize a valve consisting of a bronze body, stainless steel stem, brass plug, bronze seat, and a TFE packing. Where suitable ball-style body automatic control valves can be used and shall adhere to the following: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, NPT female end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a Tefzel flow characterizing disc. All control ball valves shall feature characterized flow guides when used for modulating applications.

.6 Unless specified otherwise, 2-way control valves for all systems shall be sized for a 4 psi (25 kPa), pressure drop or equal to the pressure drop of the coil. 2-way and 3-way control valves for radiation, reheat coils, shall have a 1 psi (6.5 kPa) pressure drop.

.7 Unless otherwise specified the minimum turn down ratio for any control valve shall be 40 to 1.

.8 Butterfly valves may be provided for two-position service. Where indicated on flow drawings, supply motorized butterfly valves complete with pipe tee of same rating as piping specification. Supply tight shut-off valves equipped with a limit switch for position indication.

.9 Approved manufacturers are Honeywell, Belimo

.3 **Valve & Damper Actuators:**

.1 Provide electric actuators of the enclosed reversible gear drive type that can accept modulating control signals or On/Off signal as required. Actuators using balance relays or mechanical travel limiting switches are not acceptable.

.2 Provide control valves with actuators sized to shut off the control valve against normal differential operating pressures.

.3 Provide damper actuators that develop sufficient force to maintain damper rated leakage characteristics. Supply actuator with limit switch for position proving as required in sequence of operation.

.4 Electric damper actuators shall be spring return on outdoor air service.

.5 Valves installed for outdoor service applications must be provided with actuators that operate satisfactorily at minus thirty (-30) degrees Celsius or warmer.

.6 Acceptable manufacturers are Honeywell, Belimo.

.4 **Carbon Monoxide / Nitrogen Dioxide Gas Detection System**

.1 The system shall be Critical Environment Technologies model FCS-4-M consisting of a programmable, digital, multi-channel controller used to monitor remote digital or analog transmitters, visually display their status with a scrolling LCD digital display and LED status indicators and initiate control actions through the board programmable relay outputs or analog output modules. The controller features shall be as follows:

.1 LED indicators show alarm status Low, Mid, High, Fault, Power.

.2 Sensor values or information is constantly updated and displayed on the LCD display, located on the front panel door. The display shall be two line by 16 character, backlit and indicates gas, gas concentration, alarm status and channel number.

.3 The controller can handle up to 8 analog transmitters or up to 32 digital transmitters and has eight built-in relays. All relays are Form C rated 5.0 amps at 240 VAC.

.4 The system power shall be 120-1-60.

.5 The controller provides three levels of alarm (low, mid and high).

.6 Provides alarm time delays and minimum fan run times.

.7 Programmable three alarm trip levels.

.8 90 db at 10'-0" (3000 mm) audible alarm, door mounted with silence / acknowledge button.

.9 Enclosure constructed of 18 gauge powder painted steel with hinged locking door and Lexan door label. Provide key lock on enclosure door.

.10 CSA / UL Tested for electrical safety.

.2 The remote sensors / transmitters shall be as follows (quantity, type and location as indicated on the drawings):

.1 Unless noted otherwise, provide digital transmitters with continuous, linear signal capable of being connect to the controller on a RS-485 communication bus and having the following features:

.1 Thermal resetting fuse.

.2 LED indicator for power, alarm and fault.

.3 Internal on line LED.

.4 Automated calibration.

.2 Digital transmitter circuits shall be housed in a wall mount, rugged, break resistant, corrosion resistant, PVC junction box with a secured, hinged door. The PVC junction box shall have conduit entry ports on the top, bottom, right side and rear. The circuit shall operate from a 24 VDC input voltage supplied from the controller.

.3 Digital wiring shall be two-conductors for low voltage power, and a two wire shielded twisted pair for the communication bus.

.4 Transmitter types shall be as follows:

.1 Carbon Monoxide: CET model DST-MCO. Where noted on the drawings, transmitters shall be provided with a watertight polycarbonate enclosure with splashguard (CET model DST-MCO-S-W). All transmitters located in the shall be provided with a protective metal enclosure (CET model DST-MCO-M). Unless noted otherwise, all sensors shall be located 4'-0" (1200 mm) above finished floor.

.2 Propane / Natural Gas: CET model DST-SCB-S-W. Provide watertight polycarbonate enclosure with splashguard. The natural gas sensors shall be mounted to the underside of the roof deck and the propane sensors shall be located 6" (150 mm) above finished floor.

.3 Carbon Dioxide: CET model AST-IC2-M analog transmitter having the following features:

.1 Automatic thermal resetting fuse.

.2 LED indicators for power and open loop.

.3 4-20 mA or 0-10 VDC linear output signal.

.4 Sensor shall be housed in a wall mount, drip-proof PVC enclosure with a hinged, secured door.

.5 Provide protective metal enclosure.

.6 All sensors shall be located 4'-0" (1200 mm) above finished floor.

.3 System operation shall be as follows:

.1 Upon detection of 25 ppm CO, 10% LEL propane / natural gas or 800 ppm CO_2, the low alarm LED will illuminate and low alarm relays will be activated. The ventilation system serving the alarm zone will be energized until the alarm condition has been removed or for a minimum time duration of 10 minutes (to avoid fan cycling).

.2 Upon detection of 50 ppm CO, 15% LEL propane / natural gas or 1000 ppm CO_2, the mid alarm LED will illuminate and mid alarm relays will be activated. The ventilation system serving the alarm zone will remain energized.

.3 Upon detection of 100 ppm CO, 20% LEL propane / natural gas or 1200 ppm CO_2, the high alarm LED will illuminate, the high alarm relays will be activated and the audible alarm will be activated. The ventilation system serving the alarm zone will remain energized. The audible alarm can be silenced from the front panel push button.

.4 Install in accordance with manufacturer's instructions and all applicable codes and regulations. Check final location of panel and sensors with Consultant if different from indicated prior to installation. Should deviations beyond allowable tolerances arise, follow Consultant's directive.

.5 Commissioning and Testing:

.1 Provide for testing and commissioning to demonstrate operation to satisfaction of engineer.

.2 Start-up, commissioning and calibration must be conducted by personnel authorized by Critical Environment Technologies. Report shall be provided.

.3 Provide first year site service and calibration 12 months after start-up date.

.5 **Low Temperature Limit Thermostats:** Low temperature thermostats shall be complete with 20 feet (6.1 m) of capillary sensitive to the nearest 12" (305 mm) and shall have a manual reset feature. The electrical contacts shall be snap acting SPDT type, rated for the application. The setpoint shall be adjustable, 35 deg. F. to 45 deg. F (1.6 deg. C to 7.2 deg. C). Provide one thermostat for each 5 sq. m of coil face or part thereof, wired in series.

.6 **High Temperature Limit Thermostats:** High temperature thermostats shall have a bimetallic sensing element which shall be mounted in the air stream. The snap acting contacts shall be rated at 120V and 5 Amps. The setpoint shall be adjustable with a minimum range of 100 deg. F to 150 deg. F, set at 135 deg. F. Provide a reset button which must be reset after the firestat has been activated. Provide one thermostat for each 5 sq. m of duct area.

.7 **Water Flow Switches:** Supply paddle actuated water flow switches with snap acting S.P.D.T. contacts rated at 16 amp 120/1/60 AC full load.

.8 **Air Proving Switches:** Air proving and motor status shall be performed by an adjustable latch level current switch. Upon motor current rise above setpoint, switch shall activate and status shall be proven.

.9 **Damper Status Switches:** Damper status switches shall be a lever operated, activated by damper blade movement and mounted securely on damper frame. Damper switch shall have contact rating of 5 Amperes at 120V AC and be CSA approved.

.10 **Temperature Sensors:**

.1 Supply factory calibrated temperature sensors that utilize 10K thermistors, 1000 ohm nickel wire, or platinum (RTDs). Temperature sensors utilized for measuring duct temperatures shall incorporate an averaging style temperature element of sufficient length to ensure a proper average of the variation across the full cross section of the duct.

.2 Temperature sensors utilized for measurement of fluid temperatures shall incorporate a separate well of a material suitable for the service. Water service - Brass

.3 Temperature sensors utilized for wall mounting in non-residential occupied spaces must be concealed with stainless steel cover

.4 Supply sensors with the following accuracy:

.1 Duct and water insertion sensors +/- 0.5% at 20 deg. C

.2 Duct averaging sensors +/- 1.0% at 20 deg. C

.3 Space sensors +/- 0.5% at 20 deg. C

.11 **Humidity Sensors:**

.1 Duct Mount Humidity Sensor: Operating range from 0% - 100%. Sensor accuracy of +/- 1% of inherent accuracy; linearity +/- 0.1% of span. End to end accuracy of +/-2% of operating range.

.2 Room Relative Humidity Sensor: Operating range from 0% - 100%. Sensor accuracy of +/- 1% of inherent accuracy; linearity +/- 0.1% of span. End to end accuracy of +/-2% of operating range. Complete with a ventilated plastic enclosure and shall be installed 1.5m above the finished floor. 0-5V output.

.3 The Outdoor humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.

.12 **Control Relays:**

.1 Control relays shall be UL Listed plug-in type with dust cover and LED "energized" indicator. DPDT relay with coils rated for 120 VAC or 24 VAC as required.

.2 Contacts rated at 10 Amps at 120 VAC. Use horsepower rated relays where required. Size to required current and voltage.

.3 Time delay relays shall be UL Listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable ±200% (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

.4 Relays are to be plug-in type with termination base.

.13 **Pressure Sensors:** Provide pressure transmitters suitable for continuous contact with the material being measured (i.e., air, water, glycol, or steam as applicable). Pressure transmitters shall have a linear output of 4-20 mA or 0-10V DC or 0-5V DC. Pressure transmitters shall have a span of not greater than twice the static pressure at maximum flow or differential pressure at shut-off as applicable.

.14 **Temperature Switches:**

.1 Temperature sensing element shall be liquid, vapour or bimetallic type. Supply adjustable setpoint and differential. Snap action type rated at 120 Volts, 15 Amps or 24 Volts DC as required.

.2 Sensors shall operate automatically and reset automatically. Temperature switches shall be of the following types:

.1 Room Type suitable for wall mounting on standard electrical box with or without protective guard.

.2 General Purpose Duct Type suitable for insertion into air ducts, insertion length of 450 mm (18 inches).

.3 Thermowell Type complete with compression fitting for 20 mm (0.8 inches) NPT well mounting of length of 100 mm (4 inches).

.4 Immersion wells shall be stainless steel.

.5 Strap-on-Type complete with helical screw stainless steel clamps.

.15 **Current Sensing Relay:** Supply current sensing relays in fan and pump motor starters to detect flow or status where required in the sequence of operation or points list, starter auxiliary contact are not suitable status points. Supply current sensing relays complete with metering transformer ranged to match load being metered. Provide adjustable latch level, a minimum differential of 10% of latch setting between latch level and release level, and an LED for local status indication. Ensure relay contacts are compatible with control circuit voltage.

.16 **Light Level Transmitter:** Resistance in darkness in excess of 1 Mohm and resistance in bright light of less than 1.5 k ohm. The transmitter to indicate the presence of absence of light. Calibrated for 4 mA in bright light > 100 foot candles and 20 mA in darkness < 0.1 foot-candles.

.17 **BAS Equipment Panels:** Local control panels shall be NEMA 1 enclosures with hinged latching doors. Mount pilot lights and/or selector switches on the front panel. CSA or ESA approval is required on the enclosure.

Part 3 - Execution

3.1 **INSTALLATION OF VALVES & DAMPERS**

.1 All automatic control valves and temperature controller wells shall be furnished by the Temperature Controls Manufacturer, but installed under his supervision by the Mechanical Contractor. All motorized control dampers, except those specified to be provided by the AHU manufacturer, shall be furnished by the Temperature Controls Contractor, but they shall be installed by the Sheet Metal Contractor.

3.2 **LABELLING**

.1 All controllers are to be labelled with the designation corresponding to the job control drawing so that each piece of equipment, controllers, relays, valves, damper motors is related to the control drawings.

3.3 **ELECTRIC WIRING**

.1 All wiring in connection with the control system shall be furnished by this Contractor to the requirements of Division 26. Inspect installation after. All relays and thermostats and controlling devices shall be of a suitable voltage for the starters specified.

.2 Power Wiring: This Contractor to provide power wiring to BAS panels. This division shall extend power wire as required to supply power to all controllers and end devices.

.3 All wiring must conform to local electrical code and must be performed by licensed journeymen and apprentice electricians. This division contractor to take out all required electrical permits and to schedule all required inspections. 110V and higher voltage shall be in conduit. Class 2 wiring shall be FT6 Teflon covered cable, concealed in ceilings and walls and where permitted exposed in finished areas, by Consultant. All exposed 24 Volt wiring shall be in conduit. All exposed wiring in mechanical rooms and other exposed/ occupied areas, shall be in conduit.

.4 Panels, Application Specific Controllers, etc., shall be located in accessible spaces for easy servicing. Application Specific Controllers (ASC) mounted in inaccessible ceiling spaces are not acceptable. All ASC's mounted in accessible ceiling spaces shall be visibly marked for location and cross referenced on the floor plans. Provide an ASC port at the sensor or via Bluetooth device.

.5 All wiring in ceiling spaces shall be neatly installed, run parallel or perpendicular to structural members and supported with mechanical fasteners to prevent sagging. Tape is not acceptable. Installation shall be to the satisfaction of the Consultant and Owner.

.6 All BAS controllers, communications and I/O components shall be hard wired.

.7 Wireless BAS system controls and equipment is NOT acceptable.

.8 All low and extra low voltage wiring shall be in conduit for new construction.

.9 For retrofit projects the use of plenum cable would be allowed in closed ceiling spaces.

.10 All control wiring shall be in conduit when installed in open areas. If installed in close ceiling spaces, FT-6 cabling shall be used. All FT-4 cabling must be installed in conduit.

.11 All BAS control wiring shall be 18 AWG and be shielded as required by the BAS being installed if not specified by the Manufacturer of the BAS system.

.12 ESA inspection required on all BAS installations.

.13 MSTP network wiring will be installed as per manufacturer recommendations.

.14 Each controller will have a wire tag to indicate from which controller the network entered and to which controller the network is running to next. To be documented in drawings including any termination resistors where applicable.

.15 Transformers and extra low voltage wiring to be documented in as built drawings

.16 All wiring to follow building lines.

.17 Colour coded wire unique to the building automation system is required.

.18 Wiring will be installed as to provide sufficient slack for servicing and will NOT rest on the ceiling tiles.

.19 Newly constructed walls shall have drops inside wall to thermostat will use conduit stubbed into the ceiling space.

.20 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.21 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

.22 Outdoor installations: use weatherproof construction in NEMA 4X enclosures.

.23 Acceptable Contractors: Must obtain ESA certification.

3.4 INSTALLATION

.1 All work that will be disruptive to the occupants shall be performed during unoccupied periods. Disruptive work shall include but not be limited to: performing electrical, device installation, mounting of controllers and panels, programming, commissioning and any work that creates excessive noise in occupied areas. Any work performed in occupied areas shall be approved by the Owner

3.5 TESTING

.1 This Section will assist the Air Balancing Agency with the testing of the air system by modulating controls to attain air volumes and temperature specified.

3.6 COMMISSIONING & PROJECT CLOSE OUT

.1 Check the installation of each sensor, actuator and controlled device.

.2 Verify the wiring of each sensor and actuator to the appropriate field termination point.

.3 Calibrate each sensor.

.4 Manually operate each actuator through the ASC.

.5 Set each control loop, observe the response to upset and to change in setpoint under full and part load operation, and tune for stable operation.

.6 Verify time clock functions, e.g. "unoccupied mode" setback.

.7 Verify alarm functions.

.8 Verify functions which reset setpoints of air and water.

.9 Verify the stability of each system, adjusting the proportional band and integral reset rate as necessary. Instruct the Owner in this procedure.

.10 Perform end-to-end checks from remote terminal to all communicating sensors and actuators to verify that database in CPU is correct.

.11 Prepare a schedule of this commissioning and provide to Owner, Consultant and Commissioning Agent one week before starting commissioning.

.12 Commissioning Procedures and Checklist Template: CoM representative(s) must witness the commissioning process.

.13 Commissioning Procedures and Checklist Template: All readings must be within plus or minus (+/- 10%) ten percent of the entire system. If this condition is not satisfied, the entire system will be required to be re-balanced.

.14 Commissioning Procedures and Checklist: Point to point commissioning to be performed.

.15 Any deficiencies identified during the commissioning process will be rectified and the commissioning process will be repeated until no deficiencies exist.

.16 Commissioning and deficiency reports shall be provided to CoM.

.17 Prepare a complete commissioning report documenting results of Items 3.6.1 through 3.6.16. Provide one page for each control point, with results of Item 3.6.1 through 3.6.10 above. Put together in 3-ring binder and submit to Consultant & Commissioning Agent for approval.

.18 Provide a detailed systematic commissioning plan to the Consultant and Commissioning Agent for review prior to execution. Commissioning shall consist of a full installation and operational checkout of each system.

.19 Commissioning Reports for Life Safety and Smoke Control systems is required before occupancy.

.20 Close Out Submissions in accordance with Section 01 78 00 - Closeout Submittals: Include:

- .1 All login IDs and passwords for all levels of access, including administrative, operator and read only
- .2 Login ID description
- .3 Software/ database backup (coding, programming etc.)
- .4 Software/ database disaster recovery procedure
- .5 Software/ database Installation and Operator Guide, Operation Manual, As-built stamped control drawings
- .6 As-built product shop drawings and specifications
- .7 Schematic of enterprise architecture
- .8 Points List
- .9 Training guide and recorded sessions (site specific)
- .10 Sequence of operation for each system on the BAS - should be in a editable format (word)
- .11 Commissioning report
- .12 All approved shop drawing submittals
- .13 Warranty signoff
- .14 Checklist that all requirements have been met
- .15 ESA inspection for all equipment and wiring
- .16 Latest version of firmware and software installed at substantial completion plus submittals of all software disks and licences provided to owner.
- .17 Certificate of Substantial Completion and Certificate of Final Completion
- .18 Maintenance Manual, Programming Guide, and User Guide

3.7 **COMMUNICATIONS REQUIREMENTS**

.1 The BAS shall communicate with the Individual Consultants Office PC by internet link provided by the Owner.

.2 The BAS shall communicate with the Contractor's Service Department by internet link provided by the Owner.

3.8 **THERMOSTAT PROTECTION & LOCATION**

.1 All thermostats and sensors in production plant use space shall have 60" mounting height with solid locking covers, locking adjustment, locking stops or heavy plastic locking covers where these features are not available.

.2 Mount heights shall conform to Ontario Building Code requirements.

3.9 **MAINTENANCE & WARRANTY**

.1 This Section shall be responsible for all maintenance and warranty of the system for one year after acceptance. Maintain communication with BAS during warranty period.

.2 Warranty to start on the date of substantial completion of the project as agreed upon via signature by both the BAS contractor and the CoM.

.3 Warranty will include all labour and parts for the BAS equipment and controls operation/algorithms for a period of two years after substantial completion.

.4 Site visit for 4 hours per week for the first month after completed commissioning is required by a programmer for correction of problems. Intermittent review required at pre-heating season and pre-cooling season.

.5 System firmware and front end software will be the most recent firmware/ software version during the warranty period and prior to warranty expiration. Must also be compatible with CoM computers and operating system.

END OF SECTION

Part 1 - General

1.1 **SECTION INCLUDES**

.1 Sequence of operation:

.1 CO_2 Domestic water heat pumps
.2 Radiant in-floor heating system
.3 Electric Boilers
.4 SCBA Room Exhaust Fan
.5 Supply fan SF-1 and exhaust fan EF-4
.6 VRF complete with Re-Heat Coils
.7 Energy Recovery Unit
.8 Dehumidifier
.9 Apparatus Bay exhaust fan EF-1
.10 Exhaust Fans - General
.11 Electrical Room Exhaust and Cooling

1.2 **RELATED SECTIONS**

.1 Section 25 50 02 - Digital Control Equipment.

.2 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 **SYSTEM DESCRIPTION**

.1 This section defines the manner and method by which controls function.

.2 Requirements for each type of control system operation are specified.

.3 Equipment, devices, and system components required for control systems are specified in other Sections.

1.4 **SUBMITTALS FOR REVIEW**

.1 Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings: Indicate mechanical system controlled and control system components.

.1 Label with settings, adjustable range of control and limits. Include written description of control sequence.
.2 Include flow diagrams for each control system, graphically depicting control logic.
.3 Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.5 **CLOSEOUT SUBMITTALS**

.1 In accordance with Section 01 78 00 - Closeout Submittals.

.2 Record Documentation: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

1.6 **QUALITY ASSURANCE**

.1 Products of This Section: Manufactured to ISO 9000 certification requirements.

.2 Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the place where the Project is located.

Part 2 - Products

2.1 **MATERIALS**

.1 Refer to Section 25 50 02.

Part 3 - Execution

3.1 **ELECTRICAL WIRING**

.1 All equipment installed under this Section shall be installed complete with all required electrical control wiring. Control wiring shall be #22 TWSH or #18 TWSH as required. Conduit shall conform to the electrical specification standards. All power wiring will be by Electrical Division 26.

.2 Power for control panels and other control equipment shall be from the nearest normal power electrical distribution panel.

3.2 **MOTORIZED COMBINATION SMOKE AND FIRE DAMPERS**

.1 Dampers shall remain open at all times except when sensing smoke and or high temperature in the duct or signal from Fire Alarm annunciation. Dampers shall close till the fire or smoke hazard has been cleared and shall be open automatically on clearing the smoke and fire alarm signal.

3.3 **CO_2 DOMESTIC HOT WATER HEAT PUMPS**

.1 System consists of the following:

.1 Two (2) outdoor heat pumps
.2 Indoor storage tank
.3 Master system control panel c/w BACnet interface

.2 The Scope of Work for Division 25 is, as follows:

.1 Install and wire all controllers for the outdoor units. Wiring shall be the size and type recommended by the heat pump Manufacturer.
.2 Division 25 wires and installs the temperature sensors between the storage tank and the master system control panel.
.3 Division 25 integrates the system via BACnet IP/MSTP interface.

3.4 **VRF SYSTEM**

.1 The System consist of the following:

.1 Fan Coils Designated FCU-1, FCU--2, etc. (total of 9 fan coils)
.2 Condensing Unit CU-1
.3 BACnet interface panel
.4 Fan Coil Controllers (one per fan coil)
.5 Heating coils designated HC-1, -2, etc. (total of 8 coils)

.2 The Scope of Work for Division 25 is as follows:

.1 Install and wire all controllers for all indoor fan coil units. Wiring shall be the size and type recommended by the VRF Manufacturer.

.2 Provide all control and interlock wiring between fan coil units branch selectors and condensing units.

.3 The sequence of control is as follows:

.1 The VRF system shall, through the BACnet interface panel operate the system on a TOD schedule programmed at the BAS.

.2 During occupied periods, the fan coil fans fun continuously. During unoccupied periods, the fans are Off.

.3 During the cooling operation, the VRF fan coil shall maintain the room temperature setpoint via the VRF controller.

.4 During the heating operation, the individual VRF fan coils shall maintain the room temperature setpoint via the VRF controller. The VRF controller shall energize the 2-way heating coil to fully open.

.5 Fan Coils serving rooms with heating coils shall operate in heating mode to -7 deg. C outdoor air temperature. At outside air temperature below -7 deg. C, the BAS shall operate the heating coils as second stage heat with the VRF fan coils providing first stage heat.

.6 Provide a 2 deg. C deadband between VRF heating setpoint and heating coils heating setpoint to provide overlap.

3.5 ELECTRIC BOILER

.1 The system consists of the following:

.1 One (1) electric boiler B-1 with modulating SCR.

.2 Boiler circulating pump

.3 Building heating pump complete with VFD.

.2 Provide Start/Stop/Status to the boiler to enable the boiler. The BAS shall sequence the boiler to maintain the following reset schedule:

Outside Air Temperature	Supply Water Temperature
-15 deg. C	65 deg. C
+18 deg. C	43 deg. C

.3 Provide Start/Stop/Status for boiler circulating pump. Boiler pump shall Start and run continuously. When the boiler shuts Off, the boiler pump shall remain On for 5 minutes, then shut Off.

.4 Supply and install water temperature sensors as indicated on the Schematic Drawings.

.5 The BAS shall supply, install and wire the flow sensor, low water cutoff, high and operating limit sensors to the boiler control panel

.6 The pump VFD for system heating pump (HP-1) shall be controlled by a pressure differential sensor to maintain setpoint. Pressure differential sensor shall be supplied, installed and wired by Division 25.

.7 The BAS shall enable the boiler and pumps at or below 20 deg. C outdoor air temperature. Above 20 deg. C, the boilers and pumps are Off.

.8 Division 25 shall integrate the boiler into the control system via BACnet IP/MSTP interface at the boiler.

3.6 DOMESTIC HOT WATER RECIRCULATING PUMP P-1

.1 The pump shall run continuously

.2 The BAS shall monitor the status of the pump.

3.7 RADIANT IN-FLOOR HEATING SYSTEM

.1 The system consists of the following:

- .1 Two (2) heating manifolds, RIH-1, -2, each complete with the following:
  - .1 3-way mixing valve
  - .2 Recirculating Pump
  - .3 Two (2) space sensors
  - .4 System controller complete with BAS interface.
- .2 The manifolds to serve the Apparatus Truck Bay
- .3 Division 25 Scope of Work is as follows (typical for each of two (2) zones):
  - .1 In-floor heating system shall energized when the boiler plant is in heating mode
  - .2 Wire the two (2) space thermostats to the controller
  - .3 Install slab sensor and wire to controller
  - .4 Wire from controller to BAS to pick-up status points at the BAS.

3.8 PLUMBING FIXTURES (INFRARED CONTROLS)

.1 For each group of plumbing fixtures, Division 26 supplies a 120V/1 phase power to a junction box in the ceiling space.

.2 Division 25 shall supply, install and wire a 120V/24V step down transformers and associated 24V wiring from junction box to each infrared plumbing fixture.

.3 Refer to Plans for plumbing fixture locations.

3.9 SCBA ROOM EXHAUST FANS EF-1

.1 The system consists of the following:

- .1 Sidewall exhaust fan EF-1
- .2 Intake motorized damper interlocked with fan (damper supplied by Division 23, damper operator supplied by Division 25)

.2 The sequence of operation is, as follows:

- .1 Fan cycles On/Off to maintain a maximum room temperature of 27 deg. C.
- .2 Division 25 shall supply, install and wire a room sensor to control the exhaust fan.
- .3 Division 25 interlocks fan with the motorized damper. When the exhaust fan starts, the motorized damper fully opens. when the exhaust fan stops, the damper closes.
- .4 BAS shall provide fan status and motorized damper.

3.10 SUPPLY FAN SF-1 AND EXHAUST FAN EF-4

.1 Exhaust fan shall run whenever the supply fan runs. Division 25 shall interlock the supply fan and exhaust fan, and interlock supply fan with motorized damper.

.2 The supply fan shall operate on a time-of-day schedule. Timeclock shall be by electrical contractor.

.3 Duct mounted temperature sensor shall be installed and wired by Division 25.

.4 BAS shall provide fan status for fan and motorized damper.

.5 BAS shall provide filter status for the supply fan.

3.11 **PULSE WATER METER**

.1 The City of Mississauga shall provide a pulse water meter on the incoming water service to the building. Division 22 installs the water meter in the Sprinkler Room.

.2 The BAS shall provide status for water consumption via the main water meter.

3.12 **MASTER MIXING VALVE**

.1 Division 25 to provide status of tempered water temperature via dry contact at the mixing valve.

3.13 **ENERGY RECOVERY UNIT ERV-1**

.1 The unit comes complete with the following:

.1 Intake filter
.2 Exhaust filter
.3 Supply fan complete with VFD
.4 Exhaust fan complete with VFD
.5 Heat recovery core complete with dampers

.2 The sequence of controls is, as follows:

.1 The unit operates on a TOD schedule as programmed at the BAS.
.2 The unit shall operate via its own factory-controlled safeties.
.3 When the unit Starts, the internal controls of the unit Start the supply and exhaust fans on low speed.
.4 Division 25 shall install and wire duct-mounted supply air, return air, exhaust air, and outdoor temperature sensors to the controller.
.5 Division 25 shall install and wire outdoor supply air duct static pressure sensor to the controller.
.6 The BAS shall monitor:

.1 Supply air temperature
.2 Return air temperature
.3 Outdoor air temperature
.4 Duct supply air static pressure
.5 Supply fan status
.6 Exhaust fan status
.7 Pre and final filter pressure differential

3.14 **CEILING HUNG FANS (CF-1, 2)**

.1 Both fans are complete with one central variable speed controller. Division 25 supplies, installs and wires a speed switch to control fan speed.

3.15 **GAS DETECTION/EF-1**

.1 Each system consists of the following:

.1 CO/NOx gas detector supplied and install by Division 25. Each gas detector is complete with two (2) remote NOx sensors and two (2) remote CO sensors.
.2 Exhaust fan EF-1
.3 Intake motorized damper

.2 The sequence of controls is as follows:

.1 Provide alarm from gas detector through the BAS whenever CO levels rise above 50 ppm or NOx levels rise above 25 ppm.

.2 When alarm sounds, the BAS shall Start and run EF-1 and open motorized damper. Fan operates until CO/NOx levels return to safe levels.

.3 Division 25 shall interlock EF-1 with intake motorized damper. Division 25 shall provide all control wiring between gas sensors, gas detector panel and associated exhaust fan and motorized damper. Install gas sensors as per manufacturer's recommendations. Division 25 interlocks the exhaust fan with the motorized damper. When the exhaust fan starts, the motorized damper fully opens. When the exhaust fan stops, the associated damper closes.

.4 Provide a spring return damper operator at each weather louvre.

3.16 DEHUMIDIFIER

.1 The unit comes with the following:

.1 Dehumidifier

.2 Filter

.3 Remote Panel

.2 Division 25 shall install the remote panel and wire to the unit.

.3 Division 15 shall wire space humidistat and wire to the controller.

.4 The sequence shall be as follows:

.1 Upon call for dehumidification, the controller shall energize the dehumidifier. The dehumidifier shall operate based oh the factory provided safety controls (minimum runtime etc.).

.5 The BAS shall measure:

.1 Filter status

.2 Fan status

.3 Space humidity

3.17 ELECTRICAL ROOM EXHAUST AND COOLING, EF-3, FCU-10, FCU-11, AND CU-2

.1 The system consists of the following:

.1 Sidewall exhaust fan EF-3

.2 Split indoor DX fan coils FCU-10, 11

.3 Outdoor condensing Unit CU-2

.4 Intake motorized damper WL-2 interlocked with fan (damper supplied by Division 23, damper operator supplied by Division 25)

.2 The sequence of operation is, as follows:

.1 The exhaust fan cycles On/Off to maintain a maximum room temperature of 25 deg. C.

.2 Division 25 shall supply, install and wire a room sensor to control the associated system in accordance with this sequence.

.3 Division 25 interlocks the exhaust fan with the respective motorized damper. When the exhaust fan starts, the motorized damper fully opens. When the exhaust fan stops, the motorized damper closes.

.4 When the room temperature reaches above 25 Dec C for a minimum amount of time, the two fan coil units shall turn on and operate. During this time the exhaust fan shall turn off and the motorized damper shall be closed.

.3 BAS shall provide fan status for the fan and motorized damper.

.4 BAS shall provide status for each fan coil and outdoor condensing unit.

BAS System - List of Control Points

System: Boilers / Point Description	ANALOG IN				BINARY IN				ANALOG OUT				BINARY OUT			PROGRAM									
	TEMPERATURE	PRESSURE	NOx	CO	STATUS	ALARM			3-13 PSIG	4 - 20 mA	PULSE		START/STOP	20 mA/13 PSIG		P.I.	ANALOG LIM	TIME SCHED.	OPTIMAL S/S	RESET	MAINTENANCE	ALARM	OFF NORMAL	TREND LOG	FAILURE MODE	GRAPHIC
VRF System and Split System (FCU-10, 11 and CU-2)																										
BACnet Gateway					X																					X
Fan Coil (Typ.)	X				X								X					X				X			X	X
Condensing Units					X								X					X				X			X	X
Fan Coil DAT	X				X																	X		X		X
Room Temp	X																	X				X		X		X
Electrical Room Cooling	X				X																	X		X		X
Filter Status		X			X																	X				X
Re-heat Coils																										
Discharge Air Temperature	X				X																	X		X		X
Valve Status and ON/OFF					X								X			X						X		X	X	X
Pressure Differential Bypass		X											X									X		X	X	X
Misc Exhaust Fans (typ.)					X								X									X		X	X	X
Space temperature	X				X																	X		X		X
Motorized Damper					X								X									X		X	X	X
Radiant In-Floor Heating (Typ.)																		X								
BACnet Gateway (Typ.)					X																					X
Room Temperature (Typ.)	X				X																	X		X		X
Outdoor Air Temperature	X				X																	X		X		X
App Bay Exhaust System																										
CO				X	X																	X		X		X
NOx			X		X								X									X		X		X
Exhaust Fan EF-1					X								X									X			X	X
Motorized Damper (typ.)					X								X									X			X	X

FAILURE MODE: **C**-LAST COMMAND **H**-HIGH LEVEL **L**-LOW LEVEL
O-ON (OPEN) **F**-OFF (CLOSED) **N**-LOCAL LOOP

BAS System - List of Control Points

System: Boilers	ANALOG IN				BINARY IN				ANALOG OUT				BINARY OUT			PROGRAM									
Point Description	TEMPERATURE	PRESSURE	NOx	CO	STATUS	ALARM			3-13 PSIG	4 - 20 mA	PULSE		START/STOP	20 mA/13 PSIG		P.I.	ANALOG LIM	TIME SCHED.	OPTIMAL S/S	RESET	MAINTENANCE	ALARM	OFF NORMAL	TREND LOG	FAILURE MODE	GRAPHIC
Dehumidifier																										
Fan					X																	X		X	X	X
Filter		X			X																	X				X
Humidity					X																	X		X	X	X
ERV-1																										
Supply Fan				X								X					X				X		X	X	X	
Supply Fan VFD				X					X			X					X				X		X	X	X	
Exhaust Fan				X								X					X				X		X	X	X	
Exhaust Fan VFD				X					X			X					X				X		X	X	X	
Supply Static Pressure		X		X																	X		X		X	
Exhaust Static Pressure		X		X																	X		X		X	
Outdoor Air Temperature	X			X																			X		X	
Filters (typ.)		X		X																	X				X	
Dampers (typ.)				X					X								X				X		X	X	X	
Circulating Pumps																										
Domestic Hot Water Recirculation P-1				X								X					X				X		X	X	X	
System Heating Pump HP-1				X								X					X				X		X	X	X	
Boiler Primary Pump				X								X					X				X		X	X	X	

FAILURE MODE: **C**-LAST COMMAND **H**-HIGH LEVEL **L**-LOW LEVEL
O-ON (OPEN) **F**-OFF (CLOSED) **N**-LOCAL LOOP

BAS System - List of Control Points

System:	ANALOG IN			BINARY IN				ANALOG OUT				BINARY OUT			PROGRAM									
Point Description	TEMPERATURE	PRESSURE	HUMIDITY	STATUS	ALARM			3-13 PSIG	4 - 20 mA	PULSE		START/STOP	20 mA/13 PSIG		P.I.	ANALOG LIM	TIME SCHED.	OPTIMAL S/S	RESET	MAINTENANCE	ALARM	OFF NORMAL	TREND LOG	FAILURE MODE	GRAPHIC
Misc Ventilation																									
Supply Fan SF-1				X								X					X				X		X	X	X
Exhaust Fan EF-4				X								X					X				X		X	X	X
Supply Air Remp Sensor	X			X								X									X				X
Filter		X		X																	X				X
Electric Boiler																	X							X	
BACnet Gateway				X																					X
Leaving water temperature	X			X																				X	X
Return Water Temperature	X			X																	X		X	X	X
Outdoor Air Temperature	X			X																	X		X		X
Flow Switch				X																	X				
LWCO				X																	X				
Op Temp Sensor	X			X																					X
High limit temp Sensor	X			X																	X				X
Domestic Hot Water Heat Pumps																	X							X	
BACnet Gateway				X																					X
Storage Tank Sensors (typ.)	X			X																	X		X		X

END OF SECTION

FAILURE MODE: **C**-LAST COMMAND **H**-HIGH LEVEL **L**-LOW LEVEL
O-ON (OPEN) **F**-OFF (CLOSED) **N**-LOCAL LOOP

City of Mississauga

Hossack & Associates Architects Inc.

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EXP Services Inc.
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END OF SECTION

Part 1 - General

1.1 **WORK INCLUDED**

.1 Conform to Section 26 05 00 - General Work Results for Electrical

Part 2 - Products

2.1 **NOT USED**

Part 3 - Execution

3.1 **REQUIREMENTS FOR MANUALS**

.1 A minimum of three copies of complete and approved operating and maintenance instructions for all electrical equipment and systems shall be supplied before Substantial Completion. Provide additional copies if required under the General Requirements. In addition to the three copies of manuals, the contractor to provide a manual in a searchable PDF format on a USB. As-Built Drawings to be included on the USB.

.2 Electronic versions of the manuals shall be provided. Microsoft Word, PDF and AutoCAD are the required formats.

.3 The Contractor to identify the cost of Record Drawings and the Operation and Maintenance Manuals as a separate line item on their progress draw. The values to be broken out can be found under Division 01. The Project will remain incomplete until the final versions, both hard and electronic, of the drawings and manuals are received and reviewed without comments.

.4 Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as "Maintenance Instructions and Data Book", for "Project name".

.5 Terminology used in all the sections shall be consistent.

.6 Volume One shall contain the master index of all systems, the name of the Contractor, Electrical Subcontractors and the date of Substantial Performance of the Work.

.7 Volume One shall contain a section with all necessary warranty information.

.8 Each binder shall have a complete index for all volumes.

.9 Each binder shall be no more than half filled.

.10 There shall be a separate section for all materials used on the project which fall under the WHMIS legislation. There shall be a hazard data sheet for each of the materials.

.11 There shall be a separate section for all Test Certificates, Verification Forms and Test Forms.

.12 All relevant information relating to a system or product shall be contained within one binder.

.13 The manual sections shall follow the specification sections.

.14 Any diagrams, installation drawings, single line diagrams charts, etc. shall be mechanically reduced while maintaining full legibility to standard page size. If this cannot be achieved they shall be carefully folded and contained within a clear plastic wallet within the manual.

3.2 **DATA FOR MANUALS**

.1 Equipment data shall contain:

.1 Operating instructions.
.2 Operating conditions such as temperature and pressure.
.3 Location of equipment.
.4 Maintenance instructions and schedules for one year routine.
.5 Recommended list of spare parts.
.6 Maintenance schedule.
.7 A troubleshooting table showing where to look for problems under various conditions of malfunction.
.8 All wiring diagrams.
.9 Equipment operating curves.
.10 Equipment nameplate data and serial numbers.

.2 System data shall contain:

.1 A listing of all systems.
.2 All panel, mcc and fire alarm schedules and locations.
.3 Equipment name tags.
.4 Cleaning, maintaining and preserving instructions for all material, products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.

.3 Sub-Contractor manuals are required for:

.1 Switchboards and power distribution systems.
.2 Lighting systems.
.3 Emergency power systems.
.4 Fire alarm systems.

.4 As-Built documentation shall contain:

.1 Reviewed As-Built Shop Drawings.
.2 As-Built Construction Drawings.
.3 Originals of test forms.
.4 Originals of test certificates.

3.3 **OPERATING INSTRUCTIONS**

.1 Instruct the Consultant in all aspects of the operation and maintenance of systems and equipment.

.2 Instruct the Owner for a minimum of five (5) working days.

.3 Arrange for and pay for the services of engineers and other manufacturers representatives required for instruction on the systems and the equipment as requested by the Consultant and/or the Owner.

.4 At the time of final inspection, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Consultant, etc.), system or equipment involved and signature of the Owner's staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.

.5 Review information with the Consultant's representative to ensure that all information required has been provided.

.6 Electrical equipment and systems included in the instruction requirements are:

.1 Switchboards and related power distribution equipment

.2 Uninterruptable Power Supplies (UPS)

.3 Fire Alarm System

3.4 **TRIAL USAGE**

.1 The Owner shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against the Owner for any injury or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or workmanship of any kind.

END OF SECTION

Part 1 - General

1.1 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC)

.4 CSA-C22.2.

.5 CAN/CSA-C22.3 No. 1, Overhead Systems.

.6 CAN3-C235, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.7 CAN/CSA-C282, Emergency Electrical Power Supply for Buildings -.

.8 Local Fire Code Requirements.

.9 Local Electrical and other low voltage systems Utility Requirements

.10 EEMAC 2Y-1, Light Gray Colour for Indoor Switch Gear.

.11 IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms.

1.2 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.

1.3 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: provide identification nameplates and labels for control items in English.

1.4 PERMITS & FEES

.1 The Consultant shall submit to the Electrical Safety Authority the necessary number of Drawings and Specifications for examination and approval prior to commencement of Work and pay the associated fees.

1.5 INSPECTION OF PREMISES & SITE

.1 Visit the site of the building and become thoroughly familiar with all conditions to be met in carrying out the Work covered by these Specifications. No extras will be allowed for failure to properly evaluate conditions that affect the scope of Work included in this Division.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit for review single line electrical diagrams under plexiglass and locate as indicated.

.1 Electrical distribution system in main electrical room.

.2 Electrical power generation and distribution systems in power plant rooms.

.2 Submit for review fire alarm riser diagram, plan and zoning of building under plexiglass at fire alarm control panel and annunciator.

.3 Shop drawings:

.1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.

.2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

.3 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.

.4 Submit required number of copies of 600 x 600 mm minimum size drawings and product data to authority having jurisdiction.

.5 If changes are required, notify Consultant of these changes before they are made.

.4 Quality Control: in accordance with Section 01 45 00 - Quality Control. Provide CSA certified equipment and material.

.1 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction and the Consultant for special approval before delivery to site.

.2 Submit test results of installed electrical systems and instrumentation.

.3 Permits and fees: in accordance with General Conditions of contract.

.4 Submit, upon completion of Work, load balance report as described in LOAD BALANCE.

.5 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Consultant.

.5 Manufacturer's Field Reports: submit to Consultant manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in FIELD QUALITY CONTROL.

1.7 **QUALITY ASSURANCE**

.1 Quality Assurance: in accordance with Section 01 45 00 - 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.

.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:

.1 In accordance with Section 01 22 00 - Meetings and Progress Reports.

.2 Site Meetings: as part of Manufacturer's Field Services described in Part 3 - FIELD QUALITY CONTROL, in appropriate CMS Section, schedule site visits, to review Work, at stages listed.

.3 After delivery and storage of products, and when preparatory Work is complete but before installation begins.

.4 Twice during progress of Work at 25% and 60% complete.

.5 Upon completion of Work, after cleaning is carried out.

.4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.8 **DELIVERY, STORAGE AND HANDLING**

.1 Material Delivery Schedule: provide the Owner's Project Manager with schedule within time frame, as agreed, after award of Contract.

1.9 **SYSTEM START-UP**

.1 Refer to Section 26 08 00 - Electrical Systems Commissioning in addition to requirements listed below.

.2 Instruct Owner's operating personnel in operation, care and maintenance of systems, system equipment and components.

.3 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.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.

1.10 **LOAD BALANCE**

.1 Measure phase current 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 and update panel directories.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Submit, at completion of Work, a report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

1.11 **OPERATING INSTRUCTIONS**

.1 Refer to Section 26 08 00 - Electrical Systems Commissioning in addition to requirements listed below.

.2 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.3 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.

.4 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.5 Post instructions where directed.

.6 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.

.7 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

Part 2 - Products

2.1 **MATERIALS AND EQUIPMENT**

.1 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.

.2 Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Inspection Department.

.3 Factory assemble control panels and component assemblies.

.4 The Specification indicates Approved Equal manufacturers (or Approved Manufacturers) for various Products, materials and systems which make up the electrical Work. The Contract Price shall be based on any of the "Approved Equals".

.5 **Basis of Design:**

.1 The Specifications may also indicate a Basis of Design manufacturer/model or system. For such cases, the specification is based on the product, equipment and/or system of the Manufacturer so named in the Specification.

.2 Products, equipment and/or systems proposed by the Approved Equal manufacturers and Suppliers named in the Specifications shall be acceptable, provided all functions and operations are provided as specified.

.3 Other products and/or systems shall also be accepted provided they are; equal in aesthetic (i.e. share the same geometric form), are of the same material, are manufactured to the same level of quality, provide equal or better performance and are offered with the same accessories and finish options as specified for the Basis of Design product/system.

.6 The Owner and Consultant reserve the right to request alternatives for any product/ system submittals that do not share the same qualities, as noted above, as those of the Basis of Design product/system listed, at no additional cost to the Owner. Unsolicited Alternate manufacturer/systems proposed during construction due to apparent long lead times and/or delivery issues shall be rejected.

.7 Unsolicited Alternate manufacturer/systems which do not appear in the Contract Documents may also be proposed, provided the following conditions are met:

.1 They appear separately in an accompanying letter attached to the Bid Form.

.2 The net dollar deduction from the Tender Price if the alternate is accepted. This value shall reflect all costs associated with the incorporation of the alternate into the Work, including any required changes in Architectural, Structural, Mechanical and other Electrical Sections and the Consultants costs of revising the design to suit.

.8 The Owner reserves the right to accept or reject any or all "Approved Alternates" or "Unsolicited Alternate" manufacturers/systems.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

.2 Control wiring and conduit: in accordance with Section 26 05 83 - Wiring Connections except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

2.3 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of authority having jurisdiction .

.2 Decal signs, minimum size 175 x 250 mm.

2.4 WIRING TERMINATIONS

.1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.5 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates: 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core.

.2 Sizes as follows:

Nameplate Sizes			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.

.3 Wording on nameplates and labels to be approved by Consultant prior to manufacture.

.4 Allow for minimum of twenty-five (25) letters per nameplate and label.

.5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

.8 Transformers: indicate capacity, primary and secondary voltages.

2.6 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, numbered 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 coding: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

2.7 **CONDUIT AND CABLE IDENTIFICATION**

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

System	Primary Colour	Secondary Colour
Fire Alarm	Red	
Low Voltage	Yellow	
Emergency Low Voltage	Yellow/Red	
UPS Low Voltage	Yellow/Blue	
High & Medium Voltage	Black	
Ground	Green	
BMS	Gray	
Information Technology	Orange	
Antennae/Satellite	Orange/Black	
Internet	Orange/Yellow	
Security	Blue	
CCTV	Green	

2.8 **FINISHES**

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.1 Paint outdoor electrical equipment "equipment green" finish.

.2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

2.9 **FIRE STOPPING**

.1 **Related Work**

.1 Coordinate work of this section with other sections as required to properly execute the work and as necessary maintain satisfactory progress of the work of other sections.

.2 References

.1 Codes and standards referenced in this section refers to the latest edition thereof.

.2 Underwriters Laboratories of Canada (ULC)

.3 CANS115, Standard Methods of Fire Tests of Firestop Systems.

.4 UL1479, Fire Tests of Through-Penetration Firestops

.5 National Building Code of Canada, Section 3.1.9

.6 CAN/ULC-S101-M Standard Methods of Fire Endurance Tests of Building Construction and Materials.

.3 Samples

.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit duplicate 300 x 300 mm samples showing actual firestop material proposed for project.

.4 Shop Drawings

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.

.3 Submit manufacturer's engineering judgement identification number and drawing details when no ULC or cUL system is available. Engineering judgement must include both project name and contractor's name who will install firestop system as described in drawing.

.5 Product Data

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 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. Include manufacturer’s specifications, training letter, and technical data for each material including the composition and limitations, documentation of ULC or CUL firestop systems to be used.

.6 Manufacturer's Representative

.1 A manufacturer’s representative is to be on site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures and at commissioning stage to certify acceptance completed installation. Training will be done as per manufacturer’s written recommendations published in their literature and drawing details.

.2 **Materials**

.1 Use only firestop products that have been ULC or cUL 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.

.2 Fire stopping and smoke seal systems: in accordance with CANS115.

.1 Asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of CANS115 and not to exceed opening sizes for which they are intended.

.2 Firestop system rating: as indicated on drawings.

.3 Service penetration assemblies: certified and tested by ULC or cUL in accordance with CANS115.

.4 Service penetration firestop components: certified and tested by ULC or cUL in accordance with CANS115.

.5 Fire resistance rating of installed fire stopping assembly in accordance with the Ontario Building Code.

.6 Non-curing, re-penetrable intumescent sealants, caulking or putty material for use with flexible cables or cable bundles.

.7 Fire stopping and smoke seals at openings around penetrations for electrical ducts, conduits, cable trays and other electrical items requiring sound and vibration control: elastomeric seal. Consult with Engineer/Architect and manufacturer prior to installation of ULC or cUL firestop systems that might hamper the performance of electrical materials.

.8 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe. No silicone based firestop are allowed to be applied on PVC pipes.

.9 Primers: to manufacturer's recommendation for specific material, substrate, and end use.

.10 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.

.11 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.

.12 Sealants for vertical joints: non-sagging.

.3 **Preparation**

.1 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.

.2 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

.4 **Installation**

.1 Install fire stopping and smoke seal material and components in accordance with ULC certification or UL Products Certified for Canada (CUL) and manufacturer's instructions.

.2 Seal holes or voids made by through penetrations, poke through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.

.3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.

.4 Tool or trowel exposed surfaces to a neat finish.

.5 Remove excess compound promptly as work progresses and upon completion.

.5 **Inspection:** Notify Engineer/Architect when ready for inspection and prior to concealing or enclosing firestopping materials and service penetration assemblies.

.6 **Schedule: Firestop and smoke seal at:**

.1 Penetrations through fire resistance rated masonry, concrete, and gypsum board partitions and walls.

.2 Edge of floor slabs at curtain wall and precast concrete panels.

.3 Top of fire resistance rated masonry and gypsum board partitions.

.4 Intersection of fire resistance rated masonry and gypsum board partitions.

.5 Control and sway joints in fire resistance rated masonry and gypsum board partitions and walls.

.6 Penetrations through fire resistance rated floor slabs, ceilings and roofs.

.7 Openings and sleeves installed for future use through fire separations.

.8 Around electrical assemblies penetrating fire separations.

.9 Rigid ducts: greater than 129 cm^2: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

.7 **Clean Up**

.1 Remove excess materials and debris and clean adjacent surfaces immediately after application.

.2 Remove temporary dams after initial set of fire stopping and smoke seal materials.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

.2 Do overhead and underground systems in accordance with CSA C22.3 No. 1 except where specified otherwise.

3.2 **NAMEPLATES AND LABELS**

.1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 **CONDUIT AND CABLE INSTALLATION**

.1 Install conduit and sleeves prior to pouring of concrete.

.1 Sleeves through concrete: schedule 40 steel pipe plastic sheet metal, sized for free passage of conduit, and protruding 50 mm.

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.4 **LOCATION OF OUTLETS**

.1 Locate outlets in accordance with Section 26 05 34 - Boxes.

.2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

.4 Locate light switches on latch side of doors.

.1 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 specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1200 mm.

.2 Wall receptacles:

.1 General: 450 mm.

.2 Above top of continuous baseboard heater: 200 mm.

.3 Above top of counters or counter splash backs: 175 mm.

.4 In mechanical rooms: 1000 mm.

.3 Panelboards: as required by Code or as indicated.

.4 Telephone and interphone outlets: 450 mm.

.5 Wall mounted telephone and interphone outlets: 1500 mm.

.6 Fire alarm stations: 1200 mm.

.7 Fire alarm bells: 2100 mm.

.8 Television outlets: 450 mm.

.9 Wall mounted speakers: 2100 mm.

.10 Clocks: 2100 mm.

.11 Door bell pushbuttons: 1500 mm.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

.2 See Submittal Requirements for protective device, coordination and arc-flash study reports.

3.7 FIELD QUALITY CONTROL

.1 **Load Balance:**

.1 Measure phase current 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 voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

.2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.

.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, communications.

.6 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 instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.4 **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 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 QUALITY ASSURANCE.

3.8 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

Transfer of Files on Electronic Media

Consultant of Record ("Consultant"): EXP Services Inc.

Contractor ("Contractor"): [ ]

Re: Fire Station 124 ("Owner"): City of Mississauga

The Contractor hereby acknowledges requesting from the Consultant, electronic data containing graphic (electronic) representation of Engineering Drawings as per attached list of Drawings, subject to the condition that the said Drawings are to be used only for information and reference in connections with the Owner's use and occupancy of the Project. The Contractor shall be responsible for checking and verifying all dimensions and details, or quantities of materials and for the co-ordination of architectural, structural, mechanical and electrical elements as required to facilitate complete and accurate fabrication and installation. Any omissions and discrepancies shall be reported to the Consultant. The Contractor hereby warrants to the Consultant that the Drawings will only be used for development of Shop Drawings/Record Drawings. The Drawings shall not be used for any other project ***or purpose*** either by the Contractor or others. The Contractor further warrants not to alter the electronic data or the information contained therein, in any way except for the above noted purposes, and acknowledges that such unauthorized use or alteration of the original work is protected in accordance with the Copyright Act and subject to penalties prescribed therein.

The Contractor hereby acknowledges that the said electronic data contain information which may be updated or altered at any time by the Consultant, and that it is the responsibility of the Contractor to make themselves aware of these changes, in a timely manner. In the event of a conflict between the Drawings issued to the Contractor and the sealed Contract Drawings, the sealed Contract Drawings shall govern.

By accepting the Drawings, the Contractor has in no way purchased the Drawings or any rights to the Drawings or the information contained therein, and the Contractor may only alter the Drawings for the purposes noted above.

The electronic files will be provided in AutoCAD format (Version 2000 or more recent). The Consultant makes no representation as to the compatibility of these files with the Contractors hardware or software beyond the specified release of the referenced software.

The Contractor shall, to the fullest extent permitted by law, indemnify, defend and hold harmless the Consultant, and its Sub-Consultants from all claims, damages, losses, expenses, penalties and liabilities for any kind, including attorney's fees, arising out of, or resulting from the use of the electronic data by the Contractor, or by third party recipients of the electronic data from the Contractor.

The Consultant believes that no licensing or copyright fees are due to others on account of the transfer of the electronic media, but to the extent any are, the Contractor will pay the appropriate fees and hold the Consultant harmless from such claims.

Any purchase order number provided by the Contractor is for Contractor's accounting purposes only. Purchase order terms and conditions are void and are not part of this agreement.

The laws of the Province of Ontario shall govern this agreement.

The conditions and undertakings expressed wherein apply to partners, employees, agents, successors, assigns and legal or other representatives of the Contractor.

Dated at _____ this _____ day of _____, 20_____.

Authorized Acceptance by Consultant

_____
Signature

Print Name and Title _____

Date _____

By Contractor

_____
Signature

Print Name and Title _____

Date _____

END OF SECTION

1266 South Service Road, Suite C1-1, Stoney Creek ON L8E 5R9 | CANADA
t: +1.905.525.6069| exp.com

Part 1 - General

1.1 SUMMARY

.1 Section Includes:

.1 Vibration isolation materials and components, seismic control measures and their installation.

.2 Related Sections:

.1 Section 26 05 00 - Common Work Results for Electrical
.2 Section 26 05 29 - Hangers and Supports for Electrical Systems
.3 Section 26 05 36 - Cable Trays
.4 Section 26 24 02 - Service Entrance Board
.5 Section 26 24 13 - Distribution Switchboards
.6 Section 26 24 16.01 - Panelboards Breaker Type
.7 Section 26 32 13 - Packaged Engine Generators Diesel
.8 Section 26 36 23 - Automatic Transfer Switches
.9 Section 26 50 00 - Lighting
.10 Section 26 52 00 - Emergency Lighting

1.2 REFERENCES

.1 Unless noted otherwise, comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC)

.4 National Building Code of Canada (NBC)

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit seismic restraint accessories that will be used to satisfy Seismic Consultant requirements

.2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit Seismic Engineering Consultant recommended materials and methods as stated in Item 3.1 below.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.5 SEISMIC BRACING DATA FOR ELECTRICAL SYSTEMS

.1 All electrical systems shall be installed to comply with the requirements of the Ontario Building Code, Paragraph 4.1.8.18 and Table 4.1.8.18.

.2 Seismic bracing for all electrical systems to meet the requirements of Table 4.1.8.18.

.3 For the purposes of calculating seismic forces the following is to be used:
Fv = 1.0
Fa = 1.0
Sa (0.2) = 0.168
IE (importance factor) = 1.5
Site Class = C

Part 2 - Products

2.1 **GENERAL**

.1 For all floor mounted equipment, provide lateral seismic resistance.

.2 Division 26 shall retain a seismic bracing consultant to supply and install seismic bracing as required. Seismic consultant shall review the installation of seismic support for all electrical equipment and provide documentation to the consultant which states that the installation complies with the requirements of OBC 4.1.8.18. Reports to be issued by a structural engineer licensed in Ontario.

.3 Division 26 to provide to seismic consultant shop drawings of all electrical equipment and co-ordinate fully with seismic restraint installation.

.4 All products shall be as recommended by the seismic consultant.

.5 All products shall be suitable for the environment of the project site.

Part 3 - Execution

3.1 **SEISMIC CONSULTING ENGINEER**

.1 Electrical contractor shall retain a seismic consulting engineer licensed in Ontario

.1 To prepare a report with recommendations, materials and methods outlining all required electrical items that require seismic bracings

.2 to arrange a preliminary site meeting prior to installation for guidance and advise

.3 to make periodic site reviews, provide reports to the project architect and other consultants

.4 to provide occupancy sign off letter to the architect which states that the installation complies with the requirements of OBC 4.1.8.18.

3.2 **INSTALLATION**

.1 Seismic Restraint of Electrical Services

.1 All seismic restraint systems shall be installed in strict accordance with the Seismic consultants report outlining restraint guidelines, product manufacturer’s manual and all certified submittal data.

.2 Installation of seismic restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.

.3 No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

.4 Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified.

.5 Prior to installation, bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

.6 Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.

.7 Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.

.8 Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

.9 Provide reinforced clevis bolts where required.

.10 Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

.11 Do not brace a system to two independent structures such as a ceiling and wall.

.12 Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement. Provide fire seal systems in fire-rated walls.

.13 Electrical contractor to provide all shop drawings including Division 27 and Division 28 to seismic consulting engineer for specific instructions on seismic restraints

3.3 ACCEPTABLE CONSULTANTS

.1 Vibro Acoustics

.2 Kinetic Noise Control

.3 E.H. Price

3.4 FIELD QUALITY CONTROL

.1 Arrange with seismic engineering consultant to review work of this section and submit written reports to verify compliance with his recommended installation methods

.2 Seismic Consultant Periodic Review:

.1 The seismic consulting engineer shall review the installation of seismic support for all electrical equipment and provide documentation to the consultant which states that the installation complies with the requirements of the National Building Code.

.2 Coordinate installation with all sub-trades.

.3 The seismic consulting engineer shall visit the site a minimum of three (3) times to review the installation and submit a written report to the Architect.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC)

.4 CSA-C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

.5 CSA-C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.

.6 CSA-C22.2 No. 48, Nonmetallic Sheathed Cable.

.7 CSA-C22.2 No. 51, Armoured Cables.

.8 CSA-C22.2 No. 52, Underground secondary and service-entrance cables.

.9 CSA-C22.2 No. 65, Wire Connectors.

.10 CSA-C22.2 No. 75, Thermoplastic-Insulated Wires and Cables.

.11 CSA-C22.2 No. 123, Metal Sheathed Cables.

.12 CSA-C22.2 No. 131, Type TECK 90 Cable.

.13 CSA-C22.2 No. 208, Fire Alarm and Signal Cable.

.14 NETA ATS, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

1.3 PRODUCT DATA

.1 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect wire and box connectors from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 BUILDING WIRES

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, RWU90 XLPE, Jacketed Non-Jacketed.

.3 Copper conductors: size as indicated, with thermoplastic insulation type THHN, THWN, T90 Nylon rated at 600 V.

2.2 **TECK 90 CABLE**

.1 **Cable:** in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 **Conductors:**

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 **Insulation:**

.1 Cross-linked polyethylene XLPE.

.2 Rating: 600V CSA.

.4 **Inner jacket**: polyvinyl chloride material.

.5 **Armour:** aluminum.

.6 **Overall covering:** thermoplastic polyvinyl chloride.

.7 **Fastenings:**

.1 One 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 or more cables at 900 mm centers.

.3 Threaded rods: 6 mm diameter to support suspended channels.

.8 **Connectors:** Watertight, approved for TECK cable.

2.3 **ARMOURED CABLES**

.1 **Conductors:** insulated, copper, size as indicated.

.2 **Type:** AC90.

.3 **Armour:** interlocking type fabricated from galvanized steel aluminum strip.

.4 **Connectors:** anti short connectors.

2.4 **ALUMINUM SHEATHED CABLE (CORFLEX)**

.1 These cables shall not be installed unless specifically noted on Drawings.

.2 **Conductors:** copper, size as indicated.

.3 **Insulation:** cross linked polyethylene type RA90 rated 600V.

.4 **Sheath:** aluminum applied to form continuous corrugated sheath.

.5 **Outer jacket:** thermoplastic applied over sheath and to be compliant to applicable Building Code classification for this project, wet locations.

.6 Fastenings for aluminum sheathed cable:

.1 One hole aluminum straps to secure surface cables 25 mm and smaller. Two hole steel straps for cables larger than 25 mm. Use aluminum strap only with single conductor cable.

.2 Channel type supports for two or more cables as indicated in Section 26 05 29 - Hangers and Supports for electrical systems.

.3 Threaded rods: 6 mm diameter to support suspended channels.

2.5 **CONTROL CABLES**

.1 **Type: LVT:** 2 soft annealed copper conductors, sized as indicated:

.1 Insulation: thermoplastic.

.2 Sheath: thermoplastic jacket, and armour of closely wound aluminum wire.

.2 **Type:** low energy 300 V control cable: solid annealed copper conductors sized as indicated LVT: 2 soft annealed copper conductors, sized as indicated:

.1 Insulation: PVC.

.2 Shielding: tape coated with paramagnetic material over each group.

.3 Overall covering: PVC jackets.

.3 **Type:** 600 V flexible stranded annealed copper conductors, sizes as indicated:

.1 Insulation: cross-linked polyethylene type

.2 Shielding: non-magnetic tape over conductors.

.3 Overall covering: thermoplastic jacket.

2.6 **NON-METALLIC SHEATHED CABLE**

.1 Non-metallic sheathed copper cable type: NMD90XLPE, size as indicated.

Part 3 - Execution

3.1 **FIELD QUALITY CONTROL**

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Perform megger tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

3.2 **GENERAL CABLE INSTALLATION**

.1 Install cable in trenches in accordance with Section 26 05 37 Duct Bank.

.2 Lay cable in cable trays in accordance with Section 26 05 36 - Cable Trays.

.3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).

.4 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.

.5 Conductor length for parallel feeders to be identical.

.6 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

.7 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

.8 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.

.9 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 **INSTALLATION OF BUILDING WIRES**

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 33 - Conduit.

.2 In underground ducts in accordance with Section 26 05 43.01.

.3 In surface and lighting fixture raceways in accordance with Section 26 05 35.

.4 In wireway and auxiliary gutters in accordance with Sections 26 05 35 and 26 05 36

.5 Overhead service conductors in accordance with Section 26 21 00.

.2 Use #12 AWG for:

.1 120V, 15A-1P circuit runs up to 18 m (60').

.2 347V, 15A-1P circuit runs up to 50 m (165').

.3 Use #10 AWG for circuit runs whose total length is in excess of those stated above.

.4 **Note:** Distances are actual conductor lengths from overcurrent device to farthest outlet.

3.4 **INSTALLATION OF TECK 90 CABLE (0 -1000 V)**

.1 Group cables wherever possible on channels.

.2 Install cable concealed, securely supported by hangers.

3.5 **INSTALLATION OF MINERAL-INSULATED CABLES**

.1 Install cable concealed, securely supported by hangers.

.2 Support 2 hour fire rated cables at 1 m intervals.

.3 Make cable terminations by using factory-made kits.

.4 Cable terminations: use thermoplastic sleeving over bare conductors.

.5 Where cables are buried in cast concrete or masonry, sleeve for entry exit of cables.

.6 Do not splice cables unless indicated.

3.6 **INSTALLATION OF ARMOURED CABLES**

.1 Group cables wherever possible on channels.

.2 Use of AC90 (BX) cables shall be limited to:

.1 Conductors from junction boxes to light fixtures not exceeding 5 ft.

.2 Shall be properly supported for good workmanship and to avoid contact with other metals such as copper pipes

3.7 **INSTALLATION OF ALUMINUM SHEATHED CABLE**

.1 Group cables wherever possible on channels.

3.8 **INSTALLATION OF CONTROL CABLES**

.1 Install control cables in conduit, cable troughs.

.2 Ground control cable shield.

3.9 **INSTALLATION OF NON-METALLIC SHEATHED CABLE**

.1 Install cables in indoor locations only (i.e. within a wall, ceiling or under floor).

.2 Will be allowed in residential applications with drywall and wood studs only.

.3 Install straps and box connectors to cables as required.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC)

.4 ANSI/IEEE 837, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

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 grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for grounding equipment for incorporation into manual.

.3 Ground resistant test results using Fall of Potential test method.

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 name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect grounding equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 EQUIPMENT

.1 Clamps for grounding of conductor: size as indicated as required to electrically conductive underground water pipe.

.2 Copper conductor: minimum 6 m long for each concrete encased electrode, bare, stranded, soft annealed, size as required.

.3 Rod electrodes: copper clad steel 19 mm diameter by minimum 3 m long.

.4 Plate electrodes: copper, surface area 0.17 m², minimum 1.6 mm thick.

.5 Grounding conductors: bare stranded copper, soft annealed, size as indicated.

.6 Insulated grounding conductors: green, copper conductors, size as indicated.

.7 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

.8 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 Pressure wire connectors.

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verification of Conditions: verify that conditions of substrate are acceptable for grounding equipment installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 **INSTALLATION GENERAL**

.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.

.2 Install connectors in accordance with manufacturer's instructions.

.3 Protect exposed grounding conductors from mechanical injury.

.4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process.

.5 Use mechanical connectors for grounding connections to equipment provided with lugs.

.6 Soldered joints not permitted.

.7 Install bonding wire for flexible conduit, connected at one end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.9 Install separate ground conductor to outdoor lighting standards.

.10 Connect building structural steel and metal siding to ground by welding copper to steel.

.11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.12 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

.13 Ground secondary service pedestals.

3.3 **ELECTRODES**

.1 Make ground connections to continuously conductive underground water pipe on street side of water meter. Ensure buried length of copper water pipe is more than 25 ft. Where buried length is less than 25 ft. or a PVC pipe, use dedicated copper ground rods (minimum 3) and a test pit.

.2 Install water meter shunt.

.3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.

.4 Install rod, plate electrodes and make grounding connections as indicated.

.5 Bond separate, multiple electrodes together.

.6 Use size 4/0 AWG copper conductors for connections to electrodes.

.7 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.4 **SYSTEM AND CIRCUIT GROUNDING**

.1 Install system and circuit grounding connections to neutral of secondary 120/208V, 3 phase system.

3.5 **EQUIPMENT GROUNDING**

.1 Install grounding 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, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

3.6 **GROUNDING BUS**

.1 Install copper grounding bus mounted on insulated supports on wall of electrical room and communication equipment room.

.2 Ground items of electrical equipment in electrical room and IT equipment in communication equipment room to ground bus with individual bare stranded copper connections size 2/0 AWG.

3.7 **COMMUNICATION SYSTEMS**

.1 Install grounding connections for telephone, sound, fire alarm, security systems, intercommunication systems as follows:

.1 Telephones: make telephone grounding system in accordance with telephone company's requirements.

.2 Sound, fire alarm, security systems, intercommunication systems as indicated.

3.8 **GROUNDING RESISTANCE**

.1 Intent of the following instructions is to achieve a low impedance (5 ohm or less) ground grid system. Contractor shall verify the above impedance by Fall of Potential tests and submit documentation per Item 1.4 above.

.2 Bond non-current carrying metal parts together with size 6 AWG copper equipotential conductor. Run conductor from separate lug or service neutral bar to, but not necessarily limited to, following indoor systems and equipment:

.1 Hot water heating system pipes (main header, etc.).

.2 Main water pipe.

.3 Main building drain.

.4 Oil/gas incoming line.

.5 Telephone, radio/TV, emergency and fire alarm lead-in or service conduits, near panels.

.6 Make connections to pipes on building side of main valves and tanks. Connect jumpers across boilers to supply and return hot water heating pipes.

.3 Drive three -19 mm diameter x 3 m copper clad ground rods at least 1.8 m apart in original undisturbed ground. If rods will not penetrate ground, drive at angle not more than 60 degrees from vertical, and in same direction. Rods must be driven, not trenched.

.4 Install ground wire from service neutral bar to rods and where buried use bare copper not smaller than size 1 AWG strand or size 4 AWG solid, and at least 640 mm below ground. Bond ground conductor, or short tap from it, to outside metal sheathing of building close to power service conduit. Use lug or cast clamp, with bronze or plated bolt, nut and washers (not sheet metal screw or wood screw). Remove paint from sheathing for good contact. Conduit is required only on outside wall of building. Indoors, run bare and fasten as specified for equipotential bonding wire.

.5 Install electrode interconnections where metal parts, circuits or grounding conductors and/or electrodes are in proximity to lightning rod conductors.

3.9 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

3.10 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 - General

1.1 RELATED SECTIONS

.1 Section 26 05 00 - Common Work Results for Electrical

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

Part 2 - Products

2.1 SUPPORT CHANNELS

.1 U shape, low carbon, strip steel, zinc coated, minimum 2.5 mm thick, surface mounted, suspended or set in poured concrete walls and ceilings.

.2 Products shall be similar to Unistrut (P1000-P3300, P4000-P9200 Series) with nuts and bolts.

Part 3 - Execution

3.1 INSTALLATION

.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.6 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole 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.

.7 Suspended support systems.

.1 Support individual cable or conduit runs with threaded rods and spring clips.

.2 Support two (2) or more cables or conduits on channels supported by threaded rod hangers where direct fastening to building construction is impractical.

.8 For surface mounting of two or more conduits use channels at 1 m on centre spacing.

.9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.11 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.12 Do not use supports or equipment installed for other trades for conduit or cable support.

.13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 - General

1.1 RELATED SECTIONS

.1 Section 26 05 00 - Common Work Results For Electrical.

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC)

.4 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.

.5 CSA C22.2 No. 45, Rigid Metal Conduit.

.6 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.7 CSA C22.2 No. 83, Electrical Metallic Tubing.

.8 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.

.9 CAN/CSA C22.2 No. 227.3, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada.

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product data: submit manufacturer's printed product literature, specifications and datasheets.

.1 Submit cable manufacturing data.

.3 Quality assurance submittals:

.1 Test reports: submit certified test reports.

.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.

Part 2 - Products

2.1 CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.

.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, with couplings and with expanded ends.

.4 Rigid PVC conduit: to CSA C22.2 No. 211.2.

.5 Flexible metal conduit: to CSA C22.2 No. 56, steel liquid-tight flexible metal.

.6 Liquid tight, flexible non-metallic conduit: to CAN/CSA-C22.2 No. 227.3.

2.2 **CONDUIT FASTENINGS**

.1 One hole steel straps to secure surface conduits 50 mm and smaller.

.1 Two hole steel straps for conduits larger than 50 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1 m on centre.

.4 Threaded rods, 6 mm diameter, to support suspended channels.

2.3 **CONDUIT FITTINGS**

.1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.

.2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.

.3 Watertight connectors and couplings for EMT.

.1 Set-screws are not acceptable.

2.4 **EXPANSION FITTINGS FOR RIGID CONDUIT**

.1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.

.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.

.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 **FISH CORD**

.1 Polypropylene.

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 datasheets.

3.2 **INSTALLATION**

.1 All installation shall be in accordance with manufacturer guidelines for the application.

.2 Use of Electrical Non Metallic Tubing (ENT) is not acceptable.

.3 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.4 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas. See drawing notes for specific locations.

.5 Use rigid galvanized steel threaded conduit below 2.4 m subject to mechanical injury.

.6 Use epoxy coated conduit underground and in corrosive areas.

.7 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.

.8 Use rigid PVC conduit underground and in corrosive areas.

.9 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without prewired outlet box, connection to surface or recessed fluorescent fixtures, work in movable metal partitions.

.10 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.11 Use explosion proof flexible connection for connection to explosion proof motors.

.12 Install conduit sealing fittings in hazardous areas.

.1 Fill with compound.

.13 Minimum conduit size for lighting and power circuits: 19 mm.

.14 Bend conduit cold:

.1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.15 Mechanically bend steel conduit over 19 mm diameter.

.16 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.17 Install fish cord in empty conduits.

.18 Maintain minimum 6" (150 mm) clearance between conduit and piping. Maintain 12" (300 mm) clearance between conduit and heat sources such as flues, steam piping, and heating appliances.

.19 Welding, brazing or other heating of conduit is not permitted.

.20 Do not obstruct spaces required by Code in front of electrical equipment, access doors, etc.

.21 Run 2-NPS 1 (25 mm) spare conduits up to ceiling space and 2 - 1" (25 mm) spare conduits down to ceiling space from each flush panel.

.1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in flush concrete or surface type box.

.22 Remove and replace blocked conduit sections.

.1 Do not use liquids to clean out conduits.

.23 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended or surface channels.

.5 Do not pass conduits through structural members except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

3.5 CONDUITS IN CAST-IN-PLACE CONCRETE

.1 Obtain approval, in writing, from structural engineer for installation of conduit in cast-in-place concrete.

.2 Locate to suit reinforcing steel.

.1 Install in centre one third of slab.

.3 Protect conduits from damage where they stub out of concrete.

.4 Install sleeves where conduits pass through slab or wall.

.5 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.

.1 Use cold mastic between sleeve and conduit.

.6 Conduits in slabs: minimum slab thickness 4 times conduit diameter.

.7 Encase conduits completely in concrete with minimum 25 mm concrete cover.

.8 Organize conduits in slab to minimize cross-overs.

3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

.1 Obtain approval, in writing, from structural engineer for installation of conduit in cast-in-place slab-on-grade.

.2 Run conduits 25 mm and larger below slab and encase in 75 mm concrete envelope.

.1 Provide 50 mm of sand over concrete envelope below floor slab.

3.7 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

3.8 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 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 RELATED SECTIONS

.1 26 05 00 - Common Work Results for Electrical

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit samples for floor box in accordance with Section 01 33 00 - Submittal Procedures.

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 low voltage switchgear from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 INTERIOR OUTLET BOXES

.1 Provide galvanized steel interior outlet wiring boxes, of the type, shape, and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Provide "gang" boxes where devices are shown to be grouped.

.2 **Type for Various Locations:**

.1 Ceilings: 4" (100 mm) square, 2-1/8" (54 mm) deep.

.2 Standard Partitions, Where 1/2" and 3/4" Conduits are Employed: 4" (100 mm) square by 2-1/8" (54 mm) deep boxes with one-gang or two-gang plaster covers shall be used.

.3 Thin Partitions Measuring 3-1/2" or Less: 4" (102 mm) square by 1-1/2" (38 mm) deep boxes with one-gang or two-gang covers shall be used.

.4 Standard Partitions, Where Conduits of a Size Greater than 3/4" (19 mmm) are Employed: 4-11/16" (119 mm) square by 2-1/8" (54 mm) deep boxes with one-gang or two-gang plaster covers shall be used.

.5 Masonry Walls: Galvanized switch boxes made especially for masonry installations; depths of boxes must be properly coordinated for each specific installation.

.6 Poured Concrete: Provide plenum type boxes without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

.7 Return Air Ceiling Plenum Boxes: In return air ceiling plenums, where 1/2" (16 mm) and 3/4" (19 mm) conduits are employed, 4" (102mm) square by 2-1/8" (38 mm) deep plenum boxes shall be used.

.8 Surface: Type "FS" or Type "FD" box with surface cover.

.9 Special: Where above types are not suitable, furnish boxes to suit the use taking into account space available, appearance, and Code requirements.

.3 **Switch Boxes:**

.1 One-gang/Two-gang Switch Boxes in Standard Walls or Partitions: If able to mount to stud, then 4x4x2-1/8; if not, shall be 3" x 2" square corner boxes by 2-1/2" deep with appropriate mounting bracket for attachment to studs.

.2 One-gang/Two-gang Switch Boxes in Thin Walls or Partitions: If able to mount to stud, then 4x4x1-1/2, if not shall be 3" x 2" square corner boxes by 1-1/2" deep with appropriate mounting bracket for attachment to studs.

.3 Three-gang and Up Switch Boxes in Standard Walls or Partitions: Shall be 4-1/2" wide solid gang boxes, with appropriate "gang" plaster covers as required.

2.3 INTERIOR OUTLET BOX ACCESSORIES

.1 Provide outlet box accessories as required for each installation, including proper covers or wall device plates, mounting brackets, wallboard hangers, extension rings, plaster rings for all boxes in plaster construction, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used, and meeting requirements of individual wiring situations.

.2 Weatherproof Outlet Boxes: Provide hot-dipped galvanized cast iron weatherproof outlet wiring boxes, of the type, shape, and size, including depth of box, with threaded conduit ends, cast metal coverplate with spring-hinged waterproof caps suitably configured for each application, including face plate gasket and corrosion resistant fasteners.

2.4 JUNCTION AND PULL BOXES

.1 Provide galvanized sheet steel junction and pull boxes, with screw-on covers and welded seams with stainless steel nuts, bolts, screws and washers, of the type, shape, and size, to suit each respective location and installation.

.2 **Type for Various Locations:**

.1 100 Cubic Inches in Volume or Smaller: Standard outlet boxes with NO stamped knockouts.

.2 150 Cubic Inches in Volume or Larger: Code gauge steel with sides formed and welded, screw covers unless shown to have hinged doors. Hinged doors with locking device same as furnished on panelboards. Formed in field with a cutting tool to provide a clean symmetrically-cut hole.

.3 Exterior or Wet Areas: Weatherproof galvanized or stainless steel construction with proper gaskets and corrosion resistant fasteners. A parking garage is considered a wet area.

2.5 CABINETS

.1 Provide cabinets of size and style noted on the Drawings.

.1 Cabinet fronts shall be steel. Other sheet metal for boxes shall be galvanized or stainless steel.

.2 The panel doors of cabinets shall be provided with locks. Single panel doors of cabinets shall have a lock with ring pull. Single doors 48" or longer and pairs of doors shall have a lock with vertical bolt operation, 3-point locking. Locks shall be keyed alike. Two keys shall be supplied for each cabinet. Panels shall all be door in hinge is have door

.3 Cabinets shall have concealed hinges.

.4 Flush-mounted trim shall be fastened to cabinet with adjustable trim clamps. Fasteners for cabinets in concealed areas shall be concealed. Shall be door in hinge type.

.5 Each voice/data cabinet shall be equipped with 3/4" (19 mm) plywood backboard covering entire inside rear surface and painted matte white with fire resistant paint.

.6 Trims and doors shall have a suitable primer coat and a finish coat of the manufacturer's standard color.

2.6 FLOOR BOXES

.1 Provide fully adjustable floor boxes for installation in concrete floors as indicated. Boxes shall be adjustable both before and after the concrete pour. Provide boxes to suit devices shown and as scheduled [below:] [on the Drawings.]

.1 Waterproof Membrane Floors - Flush Boxes: Concrete tight cast iron floor box with brass trim and service fittings to suit device shown and floor finish.

.2 Non-waterproof Membrane Floors (Above Grade) - Flush Boxes: Concrete tight steel floor box with brass trim and service fittings to suit device shown and floor finish.

2.7 FIRE-RATED POKE-THRU BOXES

.1 Fire-rated, UL-listed poke-through boxes for installation through concrete slabs. Boxes shall be suitable for the slab thickness of the building and shall have UL-listed abandon plates for use where boxes are removed. Provide poke-thru boxes to suit devices shown and as scheduled on the Drawings.

2.8 CONDUIT BOXES

.1 Provide galvanized cast Malleable Iron Form 7, clip on gasket covers conduit boxes, of the type, shape and size, to suit each respective location and installation, constructed with threaded conduit ends, removable cover, and corrosion resistant screws.

2.9 **BUSHINGS, KNOCKOUT CLOSURES, AND LOCKNUTS**

.1 Provide corrosion resistant no stamp knockouts, box knockout closures, conduit locknuts, gasketed locknuts, insulated conduit bushings and insulated grounding conduit bushings of the type and size to suit each respective use and installation.

2.10 **FITTINGS - GENERAL**

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 - Execution

3.1 **INSTALLATION OF BOXES AND FITTINGS**

.1 Install electrical boxes and fittings as shown, in compliance with electrical code requirements, these specifications, or in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes. Where boxes are concealed in exterior walls, the continuity of the vapor barrier shall be maintained behind the box.

.2 Use outlet and switch boxes for junctions on concealed conduit systems except in utility areas where exposed junction or pull boxes may be located.

.3 Determine from the Drawings and by actual determination on the site, the exact location of each outlet. The outlet locations shall be modified from those shown to accommodate changes in door swings or to clear other interferences that may arise from job construction details, as well as modification to center them within room spaces. These modifications shall be made with no change in contract price and shall be a matter of job coordination. Check these conditions throughout the entire job and notify the consultant of discrepancies, as they may occur, to verify the modifications, if any, before proceeding with the installation of the work. Set wall boxes in advance of wall construction, blocked in place and secured. Set all wall boxes flush with the finish and install extension rings as required to extend boxes to the finished surfaces of special furring or wall finishes.

.4 Install outlet boxes at heights as specified in Section 26 05 00 - Common Work Results for Electrical.

.5 On exposed conduit systems provide pull boxes, junction boxes, wiring troughs, and cabinets wherever necessary for proper installation of various electrical systems.

.6 Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.

.7 Provide knockout closures to cap unused knockout holes where blanks have been removed.

.8 Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring. Never set junction boxes above lights on lay-in ceilings.

.9 Secure boxes rigidly to the substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry. Boxes shall not be permitted to move laterally.

.10 Boxes shall be secured between two studs. Two gang (single or double device) boxes may be connected to one stud using an approved bracket, except where specific dimensioned locations must be met.

.11 Boxes for any conduit system shall not be secured to the ceiling system, HVAC ductwork, or mechanical piping.

.12 Provide junction and pull boxes for feeders and branch circuits where shown and where required by the electrical code, regardless of whether boxes are shown or not.

.13 Coordinate locations of boxes in fire rated partitions and slabs so as to not affect the fire rating of the partition or slab. Notify the Architect in writing where modifications or additional construction are required to maintain the partition or slab fire rating.

.14 All junction boxes in accessible locations shall be marked with a permanent marker to identify the circuit(s) within the box and on box cover.

.15 Junction boxes utilized for emergency circuits shall be painted red in color.

.16 Do not install boxes back-to-back in walls. Provide minimum 6" (150 mm) separation. Provide minimum 24" (300 mm) separation in acoustic-rated walls.

.17 Switch boxes shall not be used as junction boxes. Only wiring pertaining to the circuit.

.18 Install boxes in walls without damaging wall insulation.

.19 Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

.20 In inaccessible ceiling areas, position outlets and junction boxes within 6" (300 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.

.21 Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Light fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.

.22 Set floor boxes level and flush with floor. Install nonrated floor boxes as detailed on the Architectural Drawings.

.23 Locate pull boxes and junction boxes in easily accessible area, above accessible ceilings or in unfinished areas.

.24 Where outlet or switch boxes are not supported from studs or joists directly, they shall be supported by expandable clip type bar hangers, In no case shall conduit be used to support switch or outlet boxes.

.25 Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8" plaster covering back of box. 4x4x2-1/8" or 1-1/2" depending on depth.

.26 Refer to Section 26 05 00 - Common Work Results for Electrical, for applicable painting and marking of electrical boxes.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Surface metal raceways.

.2 Surface non-metal raceways.

.3 Multi-outlet assemblies.

.4 Wireways.

.5 Wall duct.

1.2 RELATED SECTIONS

.1 Section 25 05 00 - Common Work Results for Electrical

.2 Section 26 05 39 - Direct Buried Undergound Cable Ducts: Trench duct.

.3 Section 26 27 26 - Wiring Devices: Receptacles.

1.3 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA-C22.2 No. 42.1, Cover Plates for Flush-Mounted Wiring Devices.

.5 CSA-C22.2 No. 55, Special Use Switches.

.6 CSA C22.2 No. 62, Surface Raceways Systems.

.7 CAN/CSA-C22.2 No. 62.1, Nonmetallic Surface Raceways and Fittings.

.8 CSA-C22.2 No. 111, General-Use Snap Switches.

.9 CSA (Canadian Standards Association).

.10 UL (Underwriters Laboratories Inc.).

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide dimensions, knockout sizes and locations, materials, fabrication details, finishes, and accessories.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

.1 Products of this Section: Manufactured to ISO 9000 certification requirements.

.2 Perform Work to NECA Standard of Installation.

.3 Maintain one (1) copy of document on site.

.4 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.7 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by CSA/UL as suitable for purpose specified and shown.

Part 2 - Products

2.1 **SURFACE METAL RACEWAY**

.1 Manufacturers:

.1 Wiremold

.2 Thomas & Betts

.3 Substitutions: Subject to approval

.2 Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

.1 Size: As shown on Drawings.

.2 Finish: to be selected at Shop Drawing review.

.3 Fittings, Boxes, and Extension Rings: Provide manufacturer's standard accessories.

2.2 **SURFACE NON-METAL RACEWAY**

.1 Manufacturers:

.1 Wiremold

.2 Thomas & Betts

.3 Substitutions: Subject to approval

.2 Description: Plastic Fibreglass channel with fitted cover, suitable for use as surface raceway.

.3 Size: As shown on drawings.

.4 Finish: to be selected at Shop Drawing review.

.5 Fittings, Boxes, and Extension Rings: Provide manufacturer's standard accessories.

2.3 **WIREWAY**

.1 Manufacturers:

.1 Thomas & Betts

.2 Eaton Yale Company

.3 Hammond

.4 Wiremold

.5 Schneider Electric

.6 Substitutions: Subject to approval

.2 Description: General purpose, Oil-tight and dust-tight or Rain-tight type wireway.

.3 Knockouts: Manufacturer's standard.

.4 Size: Standard; length as indicated.

.5 Size: As indicated on drawings.

.6 Cover: Hinged cover with full gasketting.

.7 Connector: Slip-in.

.8 Fittings: Lay-in type with removable top, bottom, and side; captive screws and drip shield.

.9 Finish: Rust inhibiting primer coating with grey enamel finish.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install products to manufacturer's written instructions.

.2 Use flat head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.

.3 Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

.4 Wireway Supports: Provide steel channel as specified in Section 26 05 29.

.5 Close ends of wireway and unused conduit openings.

.6 Ground and bond raceway/wireway to Section 26 05 26.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 ASTM A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

.5 ASTM A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

.6 ASTM C139, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.

.7 ASTM C 478/C478M, Standard Specification for Precast Reinforced Concrete Manhole Sections.

.8 ASTM D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

.9 CAN/CSA-A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

.1 CSA-A3001, Cementitious Materials for Use in Concrete.

.10 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.11 CAN/CSA-G30.18, Billet-Steel Bars for Concrete Reinforcement.

.12 Health Canada/Workplace Hazardous Materials Information System (WHMIS) - Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 For the following items, submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.1 DB2/ES2 ducts, as applicable

.3 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.

.1 Certificates: submit certificates signed by the Utilities Inspectors certifying that materials comply with specified performance characteristics and physical properties.

.4 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

1.4 **QUALITY ASSURANCE**

.1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with contractor's representative and the Utility in accordance with Section 01 22 00 - Meetings and Progress Reports 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.

1.5 **DELIVERY, STORAGE AND HANDLING**

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 - Products

2.1 **PVC DUCTS**

.1 PVC ducts, type EB1, encased in reinforced concrete.

2.2 **PVC DUCT FITTINGS**

.1 Rigid PVC opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.

.2 Expansion joints.

.3 Rigid PVC 5 degree angle couplings.

2.3 **MANHOLES**

.1 See electrical drawings to determine whether manholes are required.

.2 Provide type indicated.

.3 Top, walls, and bottom: reinforced concrete.

.4 Walls and bottom: monolithic concrete construction.

.5 Locate duct entrances and windows near corners of structures to facilitate cable racking.

.6 Covers: fit frames without play.

.7 Form steel and iron to shape and size with sharp lines and angles.

.8 Castings: warp and blow hole free.

.9 Exposed metal: smooth finish without sharp lines and arises.

.10 Provide lugs, rabbets, and brackets.

.11 Set pulling-in irons and other built-in items in place before depositing concrete.

.12 Install pulling-in iron in wall opposite each duct line entrance.

.13 Cable racks, including rack arms and insulators: sized to accommodate cable.

2.4 **PRECAST CONCRETE MANHOLES**

.1 See electrical drawings to determine whether precast concrete manholes are required.

.2 Precast concrete manholes and auxiliary sections fabricated in steel forms.

.3 Aggregates: to CSA A23.1/A23.2.

.4 Cement: CAN/CSA-A3001, Type GU.

.5 Steel welded wire fabric mesh reinforcing: to ASTM A82/A82M, ASTM A185/A185M, CAN/CSA-G30.18.

.6 Pulling inserts and bolts for racks integrally cast in concrete:.

.7 Neoprene gasket seals between manhole sections: to ASTM D1056.

.8 Size: 762 mm clear diameter.

.9 Precast Concrete Manholes: to ASTM C478/C478M.

.1 Manhole step and ladder rung spacing: 405.

2.5 CAST-IN-PLACE CONCRETE MANHOLES

.1 See electrical drawings to determine whether cast-in-place concrete manholes are required.

.2 Smooth trowel finish for floors and horizontal surfaces.

.3 Concrete: in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.4 Construct walls on cast-in-place concrete footing except that precast concrete base sections are used for precast concrete manhole risers.

.5 Concrete block: to ASTM C139 and in accordance with Section 04 22 00 - Concrete Unit Masonry.

2.6 DRAINAGE

.1 Floor drain fittings: consisting of floor drain, back water valve, trap and pipe connection to drainage system.

2.7 MANHOLE NECKS

.1 Concrete brick and mortar.

2.8 MANHOLE FRAMES AND COVERS

.1 Cast iron manhole frames and covers.

.2 Bolted on covers to prevent unauthorized entry.

.3 Size: 762 mm clear diameter.

2.9 GROUNDING

.1 Ground rods: in accordance with Section 26 05 26 - Grounding and Bonding for cable rack grounding.

2.10 CABLE RACKS

.1 Hot dipped galvanized cable racks and supports.

.2 12 x 100 mm pre-set inserts for rack mounting.

2.11 CABLE PULLING EQUIPMENT

.1 Pulling iron: galvanized steel rods, size and shape as indicated.

.2 Pull rope: 6 mm stranded nylon, tensile strength 5 kN, continuous throughout each duct run with 3 m spare rope at each end.

2.12 **MARKERS**

.1 Concrete type cable markers: 600 x 600 x 100 mm, with words: "Cable", "Joint", "Conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.

.2 Cedar post type markers: 89 x 89 mm square, 1.5 m long, pressure treated with clear or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative, with nameplate fastened near post top, on side facing duct.

.1 Nameplate: aluminum anodized 89 x 125 mm, 1.5 mm thick mounted on cedar post with mylar label 0.125 mm thick with words "Cable", "Joint", "Conduit" with arrows to indicate change in direction.

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 datasheets.

3.2 **INSTALLATION GENERAL**

.1 Install underground duct banks and manholes including formwork.

.2 Build duct bank and manholes on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum proctor dry density.

.3 Open trench completely between manholes before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.

.4 Prior to laying ducts, construct "mud slab" not less than 75 mm thick.

.5 Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400. Slope away from the building

.6 Install base spacers at maximum intervals of 1.5 m levelled to grades indicated for bottom layer of ducts.

.7 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 and 75 mm horizontally and vertically.

.1 Stagger joints in adjacent layers at least 150 mm and make joints watertight.

.2 Encase duct bank with 75 mm thick concrete cover.

.3 Use galvanized steel conduit for sections extending above finished grade level.

.8 Make transpositions, offsets and changes in direction using 5 degree bend sections, do not exceed a total of 20 degree with duct offset.

.9 Use bell ends at duct terminations in manholes or buildings.

.10 Use conduit to duct adapters when connecting to conduits.

.11 Terminate duct runs with duct coupling set flush with end of concrete envelope when dead ending duct bank for future extension.

.12 Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.

.13 Allow concrete to attain 50% of its specified strength before backfilling.

.14 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete. Tie ducts to spacers with twine or other non-metallic material.

.1 Remove weights or wood braces before concrete has set and fill voids.

.15 Clean ducts before laying:

.1 Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.

.16 Duct cleaning:

.1 Pull 300 mm long x diameter 6 mm less than internal diameter of duct steel wooden mandrel through each duct, immediately after placing of concrete.

.2 Then pull stiff bristle brush through duct; avoid disturbing or damaging ducts where concrete has not set completely.

.3 Pull stiff bristle brush through each duct immediately before pulling-in cables.

.17 Install four 3 m lengths of 10M reinforcing rods, one in each corner of duct bank when connecting duct to manholes or buildings.

.1 Wire rods to 15M dowels at manhole or building and support from duct spacers.

.2 Protect existing cables and equipment when breaking into existing manholes.

.3 Place concrete down sides of duct bank filling space under and around ducts.

.4 Rod concrete with flat bar between vertical rows filling voids.

.18 Install pull rope continuous throughout each duct run with 3 m spare rope at each end.

3.3 MANHOLES

.1 Install precast manholes.

.2 Concrete Placement:

.1 Place concrete in two lifts with slab and sump in first, walls, roof and neck in second lift.

.2 Provide key in walls to slab.

.3 Place 100 x 6 mm PVC water bar vertically in key.

.4 Install ground rod before placing slab and place reinforcing steel, inserts for cable rack, pulling irons, drain, duct outlets, duct run dowels before casting walls. Make manhole to duct connection as indicated.

.3 Provide 115 mm deep window to facilitate cable bends in wall at each duct connection.

.1 Terminate ducts in bell-end fitting flush with window face.

.2 Provide four 10M steel dowels at each duct run connection to anchor duct run.

.3 On runs of 16 ducts and over, support concrete duct encasement on a 700 mm wide by 75 mm thick concrete pier poured against manhole wall between slab and bottom of duct run, provide dowels for anchoring.

.4 Alternately connect large duct runs by leaving square opening in wall, later pouring duct run and wall opening in one pour, and install 10M x 3m reinforcing rods in duct run at manhole connection.

.5 Build up concrete manhole neck to bring cover flush with finished grade in paved areas and 40 mm above grade in unpaved areas.

.6 Install manhole frames and covers for each manhole:

.1 Set frames in concrete grout onto manhole neck.

.7 Drain floor towards sump with 1 to 48 slope minimum and install drainage fittings as indicated.

.8 Install cable racks, anchor bolts and pulling irons as indicated.

.9 Grout frames of manholes:

.1 Cement grout to consist of two parts sand and one part cement and sufficient water to form a plastic slurry.

.10 Ensure filling of voids in joint being sealed.

.1 Plaster with cement grout, walls, ceiling and neck.

.11 Spray paint "X" on ceiling of manhole above floor drain or sump pit.

3.4 MARKERS

.1 Mark location of duct runs under hard surfaced areas not terminating in manhole with railway spike driven flush in edge of pavement, directly over run.

.1 Place concrete duct marker at ends of such duct runs.

.2 Construct markers and install flush with grade.

.2 Mark ducts every 150 m along straight runs and changes in direction.

.3 Where markers are removed to permit installation of additional duct, reinstall existing markers.

.4 Lay concrete markers flat and centered over duct with top 25 mm above earth surface.

.5 Provide drawings showing locations of markers.

3.5 FIELD QUALITY CONTROL

.1 Site Tests/Inspections:

.1 Inspection of duct will be carried out by the Utility Inspectors and the Consultant prior to placing.

.2 Placement of concrete and duct cleanout to be done when the Utility Inspectors and the consultant present.

3.6 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 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 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.

.5 CSA C22.2 No. 211.3, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control. Certificates: signed by manufacturer certifying materials comply with specified performance characteristics and physical properties.

.1 Manufacturer's Instructions: for installation and special handling criteria, installation sequence and cleaning procedures.

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 indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect low voltage switchgear from nicks, scratches, and blemishes.

.4 Replace defective or damaged materials with new.

Part 2 - Products

2.1 PVC DUCTS AND FITTINGS

.1 Do not use PVC ducts in soils that will likely contain ingredients hostile to some polymers (i.e. oils or solvents). Check with duct manufacturer for other harmful chemicals. Use fibreglass or other approved ducts where such conditions exist.

.2 Rigid PVC duct: Type DB2/ES2, with moulded fittings, for direct burial expanded flange ends, Trade size 6 or 5.

.1 Nominal length: 6 or 3 m plus or minus 12 mm.

.3 Rigid PVC split ducts.

.4 Rigid PVC bends, couplings, reducers, bell end fittings, plugs, caps, adaptors same product material as duct, to make a complete installation.

.5 Rigid PVC 90 degrees, 45 degrees bends and 5 degrees angle couplings as required.

2.2 **SOLVENT WELD COMPOUND**

.1 Solvent cement for PVC duct joints.

2.3 **FIBREGLASS DUCTS**

.1 Fibreglass reinforced thermoset duct: Type AG, Trade size 6 or 5, watertight type.

.2 Couplings, reducers, plugs, caps, adaptors, and supports to make a complete installation.

.3 Expansion joints every 18 m and as required.

2.4 **PLASTIC POLYETHYLENE PIPE (HDPE)**

.1 Flexible or Rigid plastic polyethylene pipe with approved couplings and fittings required to make complete installation for duct drainage.

2.5 **CABLE PULLING EQUIPMENT**

.1 6 mm stranded nylon pull rope tensile strength 5 kN.

2.6 **MARKERS**

.1 Concrete type cable markers: as indicated, with words: "Cable", "Joint" or "Conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.

.2 Cedar post type markers: 89 x 89 mm square, 1.5 m long, pressure treated with clear or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative, with nameplate fastened near post top, on side facing duct.

.1 Nameplate: aluminum anodized 89 x 125 mm, 1.5 mm thick mounted on cedar post with mylar label 0.125 mm thick with words "Cable" "Joint" or "Conduit" with arrows to indicate change in direction.

2.7 **WARNING TAPE**

.1 Standard 4-mil polyethylene 76 mm wide tape, yellow with black letters, imprinted with "CAUTION BURIED ELECTRIC CABLE BELOW ".

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 datasheets.

3.2 **INSTALLATION**

.1 Install duct in accordance with manufacturer's instructions and at elevations as indicated.

.2 Clean inside of ducts before laying.

.3 Install plastic duct spacers and ensure full, even support every 1.5 m and smooth transition throughout duct length.

.4 Slope ducts with 1 to 400 minimum slope or as indicated.

.5 Install plugs and cap both ends of ducts to prevent entrance of foreign materials during and after construction.

.6 Pull through each duct steel or wooden mandrel not less than 300 mm long and of diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign material.

.1 Pull stiff bristle brush through each duct immediately before pulling-in cables.

.7 Install a pull rope continuous throughout each duct run with 3 m spare rope at each end.

.8 Place continuous strip of warning tape 300 mm above duct before backfilling trenches.

.9 Install markers as required.

.10 Notify the Consultant for field review upon completion of direct buried ducts and obtain acceptance prior to backfill.

3.3 **CLEANING**

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results For Electrical.

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CAN/CSA-Z809, Sustainable Forest Management.

.5 FSC-STD-01-001, FSC Principle and Criteria for Forest Stewardship.

.6 SFI-2010 Standard.

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 cables 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 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 low voltage switchgear from nicks, scratches, and blemishes.

.4 Replace defective or damaged materials with new.

Part 2 - Products

2.1 CABLE PROTECTION

.1 38 x 140 mm planks pressure treated with clear or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative.

2.2 MARKERS

.1 Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

.2 Cedar post type markers: to CAN/CSA-Z809 or FSC or SFI 89 x 89 mm, 1.5 m long, pressure treated with clear or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative, with nameplate fastened near post top, on side facing cable or conduit to indicate depth and direction of duct and cable runs.

.1 Nameplate: aluminum anodized 89 x 125 mm, 1.5 mm thick mounted on cedar post with mylar label 0.125 mm thick with words Cable, Joint or Conduit with arrows to indicate change in direction.

Part 3 - Execution

3.1 **DIRECT BURIAL OF CABLES**

.1 Follow instructions below only if no specific details are provided on drawings.

.2 After sand bed in accordance with Section 31 23 10 - Excavating, Trenching and Backfilling, is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable.

.1 Do not pull cable into trench.

.3 Include offsets for thermal action and minor earth movements.

.1 Offset cables 150 mm minimum for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.4 Make termination and splice only as indicated leaving 0.6 m minimum of surplus cable in each direction.

.1 Make splices and terminations in accordance with manufacturer's written recommendations using approved splicing kits.

.5 Underground cable splices not acceptable for new installations.

.6 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable or in accordance with manufacturer's written recommendations; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.

.7 Cable separation:

.1 Maintain 75 mm minimum separation between cables of different circuits.

.2 Maintain 300 mm minimum horizontal separation between low and high voltage cables.

.3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.

.4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.

.5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.

.6 Install treated planks on lower cables 0.6 m minimum in each direction at crossings.

.8 After sand protective cover specified in Division 31 - Excavating, Trenching and Backfilling, is in place, install continuous row of overlapping 38 x 140 mm pressure treated planks as indicated to cover length of run.

3.2 **CABLE INSTALLATION IN DUCTS**

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.

.6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.7 After installation of cables, seal duct ends with duct sealing compound.

3.3 MARKERS

.1 Mark cable every 150 m along cable duct runs and changes in direction.

.2 Mark underground splices.

.3 Where markers are removed to permit installation of additional cables, reinstall existing markers.

.4 Install concrete cable markers within 180 m from each side of runway centreline; 45 m from each side of taxi way centreline; 50 m from edge of taxi ramps or aprons.

.5 Install cedar post type markers.

.6 Lay concrete markers flat and centred over cable with top flush with finish grade.

3.4 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Perform tests using qualified personnel.

.1 Include necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds.

.1 Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance tests:

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests:

.1 Carry out acceptable test per Specification Section - 26 08 00.

.7 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.

.8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 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 Repair damage to adjacent materials caused by cables installation.

END OF SECTION

Part 1 - General

1.1 WORK INCLUDED

.1 Conform to Section 26 05 00 - Common Work Results For Electrical .

1.2 SUMMARY

.1 The electrical power system studies for the project shall be performed by an approved electrical power systems contractor. The type and content of each study is specified in the following articles.

.2 The extent of the power systems studies shall include from: the main utility connection, the diesel generator and down to the branch circuit panels. All relays and fuse sizes to be included to ensure the best operation of the entire system.

1.3 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

1.4 SUBMITTALS

.1 Completed electrical power system studies shall be submitted to the Consultant. The study must be stamped and signed by a professional engineer.

.2 Contractor providing electrical power systems study to allow for revisions/ adjustments passed on review and actual transformer impedances.

.3 Provide a minimum of three (3) bound coloured copies to Owner and Consultant for review. Modify studies based on comments received and continue to re-issue until a final version is agreed upon.

Part 2 - Products

2.1 ELECTRICAL POWER SYSTEM STUDIES

.1 **Short-Circuit Analysis:**

.1 Calculation of maximum RMS symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer.

.2 Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.

.3 A tabular computer printout shall be included which lists the calculated short circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.

.4 The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

.5 Include a computer printout identifying the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.

.6 The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.

.7 A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided. Include recommendations as appropriate for the improvements to the system.

.8 The contractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.

.9 Any inadequacies shall be called to the attention of the engineer (architect) and recommendations made for improvements as soon as they are identified.

.2 **Protective Device Time-Current Coordination Analysis:**

.1 The time-current coordination analysis shall be performed with the aid of a digital computer and will include the determination of settings, ratings, or types for the over-current protective devices supplied.

.2 A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time current characteristics of series connected over-current devices and other pertinent system parameters.

.3 Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

.4 The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable over-current protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.

.5 A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.

.6 A discussion section which evaluates the degree of system protection and service continuity with over-current devices, along with recommendations as required for increasing system protection or device coordination.

.7 Significant deficiencies in protection and/or coordination shall be called to the attention of the Consultant and recommendations made for improvements as soon as they are identified.

.3 **Arc Flash/Incident Energy Study:**

.1 An Arc Flash/Incident Energy Study shall be performed to determine the incident energy at each piece of electrical equipment and to identify the level of PPE required by people working on that respective equipment.

.2 All equipment rated at 208V fed from a transformer less than 100 kVA are not required to be included in the study.

.3 The study shall take into account all the information set forth in the short circuit study and the coordination study.

.4 Calculate the arc flash hazard, incident energy level and the flash protection boundary as per IEEE 1584. PPE level recommendations as per CSA Z462.

.5 All electrical equipment to be identified with the incident energy, flash protection boundary and level of PPE required.

.6 Purpose made labels to be provided on all electrical equipment. All equipment where levels where not calculated are to be provided with a standard warning label. Label samples to be submitted for review by Owner and Consultant.

.4 **Ground Potential Rise Study:**

.1 Prior to the installation of grounding and bonding conductors, a Ground Potential Rise (GPR) Study shall be performed, for step potential analysis, for the entire project.

.2 GPR Study shall be stamped by a licenced professional engineer.

.3 Report shall verify bonding requirements for system for future electrification.

2.2 **APPROVED ELECTRICAL POWER SYSTEMS CONTRACTORS**

.1 The specified electrical power system studies shall be performed by:

.1 Eaton Yale Company

.2 K-Teck

.3 Schneider Electric

.4 Eastenghouse

.5 Brosz Technical Services Inc.

Part 3 - Execution

3.1 **GENERAL**

.1 The relays and equipment will be set up on site by the Technical Start-Up Services Contractor. Coordinate with this to ensure information is relayed accordingly.

.2 Review work on site to ensure equipment has been set up as per the coordination study. Have the Technical Services Start-up Contractor test systems at random to ensure the coordination study has been adhered to.

.3 Submit a report and a letter reporting to the Consultant and Owner that the coordination study information has been followed.

.4 Contractor to revise fuse sizes as identified in the report and modify the drawings to represent as-built conditions.

3.2 **LABELLING**

.1 Install arc flash labels on all equipment. Coordinate with the electrical contractor.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Electrical connections to equipment specified under other sections.

1.2 RELATED REQUIREMENTS

.1 Division 22 - Plumbing

.2 Division 23 - HVAC

.3 Section 26 05 33 - Conduit.

.4 Section 26 05 19 - Building Wire And Cable.

.5 Section 26 05 34 - Boxes.

1.3 REFERENCE STANDARDS

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC)

.4 NEMA WD 6-2012 - Wiring Devices - Dimensional Requirements.

.5 NEMA WD 1 - General Colour Requirements for Wiring Devices.

.6 NFPA 70 - National Electrical Code (NEC).

.7 CSA (Canadian Standards Association).

.8 UL (Underwriters Laboratories Inc.).

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

.1 Coordinate with other work having a direct bearing on work of this section.

.2 Obtain and review shop drawings, product data, and manufacturer's instructions for equipment provided under other sections.

.3 Determine connection locations and requirements.

.2 Sequencing:

.1 Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

.2 Sequence electrical connections to coordinate with start-up schedule for equipment.

1.5 ACTION SUBMITTALS

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide wiring device manufacturer's catalogue information showing dimensions, configurations, and construction.

1.6 INFORMATIONAL SUBMITTALS

.1 Section 01 33 00 - Submittal Procedures.

.2 Installation Data: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.7 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by CSA, UL or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

Part 2 - Products

2.1 **CORDS AND CAPS**

.1 Attachment Plug Construction: Conform to NEMA WD 1.

.2 Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

.3 Specify Type SJO (hard usage), Type SO (extra hard usage), or other special cord type as required.

.4 Cord Construction: NFPA 70 or CSA-C22.1, Type SO or SJO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

.5 Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit over-current protection.

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verify existing conditions before starting work.

.2 Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 **ELECTRICAL CONNECTIONS**

.1 Make electrical connections to equipment manufacturer's written instructions.

.2 Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.

.3 Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

.4 Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.

.5 Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

.6 Install disconnect switches, controllers, control stations, and control devices as indicated.

.7 Modify equipment control wiring with terminal block jumpers as indicated.

.8 Provide interconnecting conduit and wiring between devices and equipment where indicated.

.9 Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION

Part 1 - General

1.1 RELATED DOCUMENTS

.1 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

.2 Section 26 05 00 - Common Work Results for Electrical

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC)

.4 Standard for Acceptance Testing Specification for Electrical Power Equipment and Systems, ANCI/NETA ATS

1.3 SUMMARY

.1 The purpose of this Section is to define Contractor responsibilities in the commissioning process, which are being directed by the Contractor. Other electrical system testing is required under other Division 26 Specification Sections.

.2 Commissioning requires the participation of the Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. General Commissioning requirements and coordination are detailed in Division 01. Division 26 shall be familiar with all parts of Division 01 and the Commissioning Plan issued by the Contractor and shall execute all Commissioning responsibilities assigned to them in the Contract Documents and include the cost of Commissioning in the Contract price.

.3 Electrical systems to be commissioned include, but are not limited to, the following:

.1 Secondary Service Electrical Systems (transformers, feeders and branch circuits)
.2 Emergency battery units and lighting systems
.3 Distribution and Branch Circuit Panelboards.
.4 Lighting Fixtures and Controls.
.5 Lightning Protection Equipment and Lightning Protection Systems.
.6 Power factor correction equipment.
.7 Fire Alarm Equipment/Fire Alarm Equipment Monitoring System.
.8 AC Motors.
.9 Grounding Systems.
.10 Emergency Generators, automatic transfer switches and Distribution System.
.11 Uninterruptible Power Systems.

1.4 REFERENCE STANDARDS

.1 The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

.2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

.3 All materials, installation and workmanship shall comply with the applicable requirements and standards.

1.5 **DEFINITIONS**

.1 Commissioning: A systematic process confirming that building systems have been installed, properly started, and consistently operated in strict accordance with the Contract Documents, that all systems are complete and functioning in accordance with the Contract Documents at Substantial Completion, and that Contractor has provided Owner adequate system documentation and training. Commissioning includes deferred and/or seasonal tests as approved by Owner.

.2 Commissioning Plan: Document prepared by Contractor and approved by Architect/ Engineer that provides the structure, schedule, and coordination plan for the Commissioning process from the construction phase through the warranty period. The Commissioning Plan must satisfy the Owner's test requirements.

.3 Commissioning Team: Working group made up of representative(s) from the Architect/Engineer (A/E), Contractor, Owner's Test, Adjust, and Balance (TAB) Firm, Building Automation System (BAS) provider, specialty manufacturers and suppliers, and Owner. Contractor will provide ad-hoc representation of Subcontractors on the Commissioning Team as required for implementation of the Commissioning Plan.

.4 Deferred Tests: Functional Performance or Integrated System Tests performed after Substantial Completion due to partial occupancy, partial equipment acceptance, seasonal requirements, design, or other Site conditions that prohibit the test from being performed prior to Substantial Completion.

.5 Deficiency: Condition of a component, piece of equipment or system that is not in compliance with Contract Documents.

.6 Factory Testing: Testing of equipment at the factory, by factory personnel with an Owner's representative present if deemed necessary by Owner.

.7 Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configuration and steps required to determine if the system is performing and functioning properly. Contractor prepares these procedures to document Functional Performance Tests.

.8 Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems executed by Contractor. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Functional Performance Tests are executed after start-ups and Pre-functional Checklists are complete.

.9 Integrated System Test: Test of dynamic function and operation of multiple systems. Integrated System Tests are tested under various modes, such as fire alarm and emergency situations, life safety conditions, power failure, etc. Systems are integrally operated through all specified sequences of operation. Components are verified to be responding in accordance with Contract Documents. Integrated System Tests are executed after Functional Performance Tests are complete and prior to Substantial Completion. Integrated System Tests provide verification that the integrated systems will properly function according to the Contract Documents.

.10 Integrated System Test Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configurations and steps required to determine if the interacting systems are performing and functioning properly. Contractor prepares these procedures to document Integrated System Tests.

.11 Pre-functional Checklist: A list of static inspections and material or component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.). The word Pre-functional refers to before Functional tests. Pre-functional Checklists must include the manufacturer's Start-up checklist(s). Contractor shall sign Pre-functional Checklists as complete and submit with the Request for Start-up/Functional Performance Test Form.

.12 Start-up: The activities where equipment is initially energized, tested, and operated. Start-up is completed prior to Functional Performance Tests.

.13 Test Requirements: Requirements specifying what systems, modes and functions, etc. must be tested. Test requirements are not detailed test procedures. Test requirements and acceptance criteria are specified in the Contract Documents.

1.6 **SUBMITTALS**

.1 Contractor shall prepare Pre-functional Checklists and Functional Performance Test (FPT) procedures and execute and document results. All Pre-functional Checklists and tests must be documented using specific, procedural forms in Microsoft Word or Excel software developed for that purpose. Prior to testing, Contractor shall submit those forms to the Architect/Engineer for review and approval.

.2 Contractor shall provide Owner with documentation required for Commissioning work. At minimum, documentation shall include: Detailed Start-up procedures, Full sequences of operation, Operating and Maintenance data, Performance data, Functional Performance Test Procedures, Control Drawings, and details of Owner-Contracted tests.

.3 Contractor shall submit to Owner installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians.

.4 Contractor shall review and approve other relative documentation for impact on FPT's of the systems:

.1 Shop Drawings and product submittal data related to systems or equipment to be commissioned. The Subcontractor responsible for the FPT shall review and incorporate comments from the Owner and A/E via the Contractor.

.2 Incorporate manufacturer's Start-up procedures with Pre-functional checklists.

.3 Draft Electrical Testing Agency (ETA) Reports: Review and provide comments to Architect/Engineer.

.4 Factory Performance Test Reports: Review and compile all factory performance data to assure that the data is complete prior to executing the FPT's.

.5 Completed equipment Start-up certification forms along with the manufacturer's field or factory performance and Start-up test documentation: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT's.

.6 Final ETA Reports: Subcontractor performing the test will review the documentation prior to commencing with the scheduled FPT's.

.7 Operating and Maintenance (O&M) information per requirements of the Technical Specifications and Division 01 requirements: To validate adequacy and completeness of the FPT, the Contractor shall ensure that the O&M manual content, marked-up record Drawings and Specifications, component submittal drawings, and other pertinent documents are available at the Project Site for review.

Part 2 - Products

2.1 **GENERAL**

.1 All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 **TEST EQUIPMENT**

.1 Provide all specialized tools, test equipment and instruments required to execute Start-up, checkout, and testing of equipment.

.2 All specialized tools, test equipment, and instruments required to execute Start-up, checkout, and testing of equipment shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated test equipment within the previous twelve (12) months. Contractor must calibrate test equipment and instruments according to manufacturer's recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

.3 Infrared Thermographic Scanner:

.1 Infrared scanning equipment shall be an AGA (or approved equal) thermovision set capable of viewing an entire bus or equipment assembly at one time and have a sensitivity of 0.2 degrees C with a liquid nitrogen reference.

.2 All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified.

Part 3 - Execution

3.1 **PREPARATION**

.1 Construction Phase:

.1 In each purchase order or subcontract that is written for changes in scope, include the following requirements for submittal data, Commissioning documentation, testing assistance, Operating and Maintenance (O&M) data, and training, as a minimum.

.2 Attend Pre-Commissioning Meeting(s), Pre-Installation Meeting(s), and other Project meetings scheduled by the Contractor to facilitate the Commissioning process.

.3 Provide manufacturer's data sheets and shop drawing submittals of equipment.

.4 Provide additional requested documentation to the Contractor, prior to O&M manual submittals, for development of Pre-functional Checklist and Functional Performance Tests procedures.

.1 Typically, this will include detailed manufacturer's installation and Start-up, operating, troubleshooting and maintenance procedures, full details of any Owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified.

.2 In addition, the installation, Start-up, and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Contractor.

.3 This information and data request may be made prior to normal submittals.

.5 With input from the BAS Provider and A/E, clarify the operation and control of commissioned equipment in areas where the Specifications, BAS control drawings, or equipment documentation are not sufficient for writing detailed test procedures.

.6 Prepare the specific Functional Performance Test procedures.

.7 Develop the Commissioning Plan using manufacturer's Start-up procedures and the Pre-functional Checklists. Submit manufacturer's detailed Start-up procedures and the Commissioning Plan and procedures and other requested equipment documentation to Owner for review.

.8 During the Start-up and initial checkout process, execute and document related portions of the Pre-functional Checklists for all commissioned equipment.

.9 Perform and clearly document all completed Pre-functional Checklists and Start-up procedures. Provide a copy to the Architect/Engineer prior to the Functional Performance Test.

.10 Address current Architect/Engineer and Owner punch list items before Functional Performance Tests. Air and water test, adjust and balance shall be completed with discrepancies and problems remedied before Functional Performance Tests of the respective air or water related systems are executed.

.11 Provide skilled technicians to execute starting of equipment and to assist in execution of Functional Performance Tests. Ensure that they are available and present during the agreed-upon schedules and for a sufficient duration to complete the necessary tests, adjustments, and problem solving.

.12 Correct deficiencies (differences between specified and observed performance) as interpreted by the Owner's Project Manager and Architect/Engineer and retest the system and equipment.

.13 Compile all Commissioning records and documentation to be included in a Commissioning and Closeout Manual.

.14 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

.15 During construction, maintain as-built marked-up Drawings and Specifications of all Contract Documents and Contractor-generated coordination Drawings. Update after completion of Commissioning activities (include deferred tests). The as-built drawings and specifications shall be delivered to the Owner both in electronic format and hard copies as required by the Owner.

.16 Provide training of the Owner's operating personnel as specified.

.17 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

.2 Warranty Phase:

.1 Execute seasonal or deferred tests, witnessed by the Owner, according to the Specifications.

.2 Complete deferred tests as part of this Contract during the Warranty Period. Schedule this activity with Owner. Perform tests and document and correct deficiencies. Owner may observe the tests and review and approve test documentation and deficiency corrections.

.3 If any check or test cannot be completed prior to Substantial Completion due to the building structure, required occupancy condition, or other condition, execution of such test may be delayed to later in the Warranty Period, upon approval of the Owner. Contractor shall reschedule and conduct these unforeseen deferred tests in the same manner as deferred tests.

.4 Correct deficiencies and make necessary adjustments to O&M manuals, Commissioning documentation, and as-built drawings for applicable issues identified in any seasonal testing.

.3 Electrical Testing Agency (ETA):

.1 The Contractor shall retain an independent Electrical Testing Agency (ETA). Their specific testing responsibilities include checking and testing of the electrical power distribution equipment per National Electrical Testing Association (NETA).

.2 Attend Pre-Commissioning Meeting(s), Pre-Installation Meeting(s), and other Project meetings scheduled by the Contractor to facilitate the Commissioning process.

.3 Obtain all required manufacturer's data to facilitate tests.

.4 Provide assistance to the Contractor in preparation of the specific Pre-functional Checklist and Functional Performance Test procedures. Generally ETA shall provide their standard forms to document the NETA tests to be incorporated into the Pre-functional Checklist and Functional Performance Tests record.

.5 During related tests, execute and document the tests in the approved forms and/or test record.

.6 Perform and clearly document all completed Start-up and system operational checkout procedures, providing a copy to the Contractor.

.7 Clearly indicate any deficiencies identified during testing and add to an action list for resolution and tracking. The field technicians shall keep a running log of events and issues. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, Contract interpretation requests and lists of completed tests to the Contractor at least twice a week and provide technical assistance in the resolution of deficiencies.

.8 Provide skilled technicians to execute testing. Ensure that they are available and present during the agreed-upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

.9 Warranty Phase: Perform thermographic imaging of loaded panel at time designated by Electrical Subcontractor or Contractor.

3.2 INSTALLATION

.1 Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

.2 All installation shall be in accordance with manufacturer's published recommendations.

3.3 TESTING

.1 Acceptance tests:

.1 Follow the Acceptance Test procedures specified in this Section.

.2 Pre-functional Checklists and Start-up:

.1 Follow the Start-up and initial checkout procedures specified by Manufacturer for specific equipment. Start-up and complete systems and sub-systems so they are fully functional, meeting the requirements of the Contract Documents.

.2 Pre-functional Checklists shall be complete prior to commencement of a Functional Performance test.

.3 Functional Performance Tests:

.1 Functional Performance Tests are conducted after system Start-up and checkout is satisfactorily completed.

.2 Refer to specifications for specific details on the required Functional Performance Tests.

.4 Coordination Between Testing Parties:

.1 Factory Start-ups: Factory Start-ups are specified for certain equipment. Factory Start-ups generally are Start-up related activities that will be reviewed and checked prior to Functional Performance Tests. All costs associated with factory Start-ups shall be included with the contract price unless otherwise noted. Notify the Commissioning Team of the factory Start-up schedule and coordinate these factory Start-ups with witnessing parties. The Commissioning Team members may witness these Start-ups at their discretion.

.2 Independent Testing Agencies: For systems that specify testing by an independent testing agency, the cost of the test shall be included in the Contract price unless otherwise noted. Testing performed by independent agencies may cover aspects required in the Pre-functional Checklists, Start-ups, and Functional Performance Tests. Coordinate with the independent testing agency so that Owner and/or A/E can witness the test to ensure that applicable aspects of the test meet requirements.

3.4 **TRAINING**

.1 Submit a written training plan to the Owner and Architect/Engineer for review and approval. Contractor's training plan shall cover the following elements:

.1 Equipment included in training.

.2 Intended audience.

.3 Location of training.

.4 Objectives.

.5 Subjects covered.

.6 Duration of training on each subject.

.7 Instructor for each subject.

.8 Methods (classroom lecture, video, Site walk-through, actual operational demonstrations, written handouts, etc.).

.9 Instructors and qualifications.

.2 Contractor shall have the following training responsibilities:

.1 Provide a training plan ten (10) calendar days prior to the scheduled training, in accordance with Division 01.

.2 Provide Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned mechanical equipment or system.

.3 Training shall start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including Start-up, shutdown, fire/smoke alarm, power failure, etc.

.4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

.5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This representative may be the Start-up technician for the piece of equipment, the installing contractor, or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.

.6 The training sessions shall follow the outline in the Table of Contents of the O&M manual and illustrate whenever possible the use of the O&M manuals for reference.

.7 Training shall include:

.1 Usage of the printed installation, operation and maintenance instruction material included in the O&M manuals.

.2 Review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include Start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.

.3 Discussion of relevant health and safety issues and concerns.

.4 Discussion of warranties and guarantees.

.5 Common troubleshooting problems and solutions.

.6 Explanation of information included in the O&M manuals and the location of all plans and manuals in the facility.

.7 Discussion of any peculiarities of equipment installation or operation.

.8 Hands-on training shall include Start-up, operation in all modes possible, including manual, shutdown, and any emergency procedures and maintenance of all pieces of equipment

.9 Training shall occur after Functional Performance Tests are complete and shall be scheduled with the Owner's Project Manager.

.3 Provide training on each system/piece of equipment according to the following schedule:

Hours	System
8 hours minimum	Normal Power & Distribution Systems
2 hours minimum	Lighting
3 hours minimum	Fire Alarm System
4 hours minimum	Lighting Controls
3 hours minimum	Emergency Generator and Emergency Power System
2 hours minimum	Uninterruptible Power System (UPS)
2 hours minimum	Telecommunications and Data
3 hours minimum	Miscellaneous Systems

END OF SECTION

Part 1 - General

1.1 SUBMITTALS

.1 Submit shop drawings for products specified in this Section.

1.2 PRODUCT COMPATIBILITY

.1 Lighting controls and luminaires when integrated together for control purposes must be 100% compatible with each other. Coordinate with ballast/driver and lamp manufacturers, LV relay panel manufacturers and dimmer/occupancy control manufacturers to ensure that components are compatible with each other and that interconnections do not affect performance, life or any warranties.

Part 2 - Products

2.1 PHOTO CELLS

.1 Intermatic Inc., K4100 Series, CSA approved, 120/347 V as required, weather-proof photo-control with a hermetically sealed cadmium sulphide photo cell, colour coded leads, adjustable light level slide, swivel, threaded pipe stem and heavy duty die cast housing. Unit to be designed such that load remains on if cell fails, and to be complete with thermal inertia time delay to prevent switching by artificial light.

.2 Acceptable manufacturers are:

- .1 Intermatic Inc.;
- .2 Paragon Electric;
- .3 Tork Canada Ltd;
- .4 Acuity Brands Controls;
- .5 Cooper Controls.

2.2 PHOTO TIMER CONTROLLERS

.1 Tork Phototimer series 5737TZ, CSA approved, microprocessor controlled photo timer with features as follows:

- .1 silicon photosensor;
- .2 microprocessor tracks dusk and dawn times for 24 hours and automatically sets its internal calendar in order to turn OFF at midnight during all seasons; back ON before dawn, and OFF at sunrise
- .3 automatically adjusts for daylight savings time;
- .4 two potentiometers are to be provided: one allows for field adjustment for longitude corrections or for additional energy savings; other allows user to set number of hours after middle of night that lights turn back on (AM burn);
- .5 solid brass locking type prongs;
- .6 relay provides positive snap action switching to assure a minimum contact life of 5000 operations;
- .7 surge protection provided using a metal oxide varistor of 160 joules minimum;
- .8 enclosure of ANSI colour code, high impact, UV stabilized polypropylene and contain a UV resistant clear acrylic window; base of ABS construction with a cross linked polyethylene gasket;
- .9 provides a load rating of 1000 watt tungsten, 1800 VA ballast;
- .10 must fail in the on position.

.2 Include for required wiring, standard turn-lock receptacle and mounting hardware.

.3 Acceptable manufacturers are:

.1 Tork;
.2 Intermatic;
.3 Paragon Electric;
.4 Acuity Brands Controls;
.5 Cooper Controls.

2.3 MECHANICAL TIME SWITCHES

.1 Intermatic Inc., V4547 Series, CSA approved, adjustable, surface wall mounted, mechanical time switch with Astro dial, skipper, carryover, 40 ampere rated switch contacts, and minimum EEMAC 3R raintight enclosure with lockable hinged door.

.2 Time switch to adjust for seasonal changes automatically. Skippers to omit selected dates from program. Carryover to provide minimum 16 hours of pre-set schedule during power outages.

.3 Exact model must suit intended application.

.4 Acceptable manufacturers are;

.1 Intermatic Inc.;
.2 Paragon Electric;
.3 Tork Canada Ltd;
.4 Acuity Brands Controls;
.5 Cooper Controls.

2.4 ELECTRONIC TIMERS

.1 Electronic timers for indoor applications to control fluorescent/incandescent lighting loads or motor loads (where occupancy sensor is not suitable or required) to be provided as required for applications. Electronic timers to be equal to Tork 'Digital Elite - SSA' series, CSA approved types with features as follows:

.1 flush mounting into single gang wall box;
.2 solid state electronics with LCD display;
.3 8 interval pre-sets;
.4 tamper resistant time-on interval can be pre-set;
.5 flicker of lights and/or beep audible warning begins 2 minutes before time-out;
.6 no minimum loads required;
.7 complete with decorator type face with matching faceplate.

.2 Provide STI type polycarbonate, tamper-proof hinged locking cover on timers located in hazardous locations or where identified on drawings.

.3 Acceptable manufacturers are:

.1 Tork;
.2 Intermatic;
.3 Paragon Electric;
.4 Acuity Brands Controls;
.5 Cooper Controls.

2.5 **WALL BOX DIMMERS**

.1 Lutron Electronics Co. "Nova-T" Series, ULC listed and labelled, CSA approved wall box dimmers as follows:

.1 of type and size to suit intended loads;

.2 air gap accessible without removing faceplate, to meet UL20 and UL1472 short circuit test requirement for snap switches;

.3 withstand voltage surges up to 600 V and current surges up to 200 A as per ANSI/IEEE C62.41;

.4 voltage regulated;

.5 power failure memory;

.6 LC filtering to minimize RFI;

.7 linear slide with smooth and continuous square law dimming curve operation;

.8 snap on faceplate (seamless multi-gang at locations with multiple devices);

.9 finish to Consultant's direction.

.2 Where noted for applications of multiple wall box dimmers located in one location, provide CSA approved, NEMA 2 type, flush wall mounting, electrical cabinet with hinged locking front door, of painted enamel painted steel construction, complete with conduit knockout entries, flush trim and sized to accommodate dimmers. Refer to applicable drawing detail.

.3 Acceptable manufacturer are:

.1 Acuity Brands Controls;

.2 Lutron;

.3 Cooper Controls.

2.6 **OCCUPANCY SENSORS (STANDARD)**

.1 Legrand - Watt Stopper, CSA approved devices to provide automatic control of lighting with following components:

.1 power and slave packs;

.2 dual technology occupancy sensors;

.3 controls and daylight sensors;

.4 wiring in conduit and mounting hardware.

.2 Where required, power packs to be self-contained, 347/120 VAC/24 VDC (or of voltage shown on drawings) transformer relay system. Slave packs to contain isolated relay. System to allow one sensor to control luminaires circuited to both essential power circuits and normal power circuits.

.3 For applications in general areas: ceiling mounted, CI-305, PIR technology type occupancy sensors as follows:

.1 low voltage operation;

.2 360° lens area coverage, extending out up to 13 m (44') and area of 111 m^2 (1200 ft^2);

.3 low profile ceiling mounting design;

.4 passive infrared technologies;

.5 integral light sensor;

.6 adjustable sensitivity and digital time delay;

.7 walk-through mode;

.8 LED indication of occupancy detection;

.9 isolated relay for interconnection to auxiliary control systems where required.

.4 For applications in general areas: ceiling mounted, DT-300, dual technology type sensors as follows:

.1 combination passive infrared and ultrasonic technologies;

.2 when both PIR and ultrasonic technologies detect occupancy, lights turn ON automatically; once lights are ON, detection by either technology holds lights ON until occupancy is no longer detected and time delay elapses;

.3 low voltage operation;

.4 360° lens area coverage, extending out up to 6 m (20') and area of 92.9 m^2 (1000 ft^2);

.5 low profile ceiling mounting design;

.6 integral light sensor;

.7 adjustable sensitivity and digital time delay;

.8 walk-through mode;

.9 LED indication of occupancy detection;

.10 isolated relay for interconnection to auxiliary control systems where required.

.5 For applications in general areas: ceiling mounted, DT-355, dual technology type sensors as follows:

.1 combination passive infrared and ultrasonic technologies;

.2 when both PIR and ultrasonic technologies detect occupancy, lights turn ON automatically; once lights are ON, detection by either technology holds lights ON until occupancy is no longer detected and time delay elapses;

.3 can be set so that only one technology is needed to trigger;

.4 low voltage operation;

.5 360° lens area coverage, extending out up to 6 m (20') and area of 92.9 m^2 (1000 ft^2);

.6 low profile ceiling mounting design;

.7 integral light sensor;

.8 adjustable sensitivity and digital time delay;

.9 walk-through mode;

.10 LED indication of occupancy detection;

.11 isolated relay for interconnection to auxiliary control systems where required.

.6 For sensors mounted in ceiling/wall corners: series DT-200 with features as follows:

.1 combination passive infrared and ultrasonic technologies;

.2 when either or both (user set option) PIR and ultrasonic technologies detect occupancy, lights turn ON automatically; once lights are ON, detection by either technology holds lights ON until occupancy is no longer detected and time delay elapses;

.3 complete with adjustable swivel mounting bracket;

.4 wide dispersion lens area coverage, extending out up to 16 m (55') and area of 185 m^2 (2000 ft^2);

.5 low voltage operation;

.6 low profile design;

.7 integral light sensor;

.8 adjustable sensitivity and digital time delay;

.9 walk-through mode;

.10 LED indication of occupancy detection;

.11 isolated relay for interconnection to auxiliary control systems where required.

.7 For applications in washrooms and small storage rooms: wall mounted "DW-100" Series dual technology sensors as follows:

.1 wall switch sensor turns lights OFF and ON based on occupancy;

.2 factory default operation is for Manual-ON mode, so that users turn light on only when needed;

.3 variety of control options including Auto-ON operation, walk-through and test mode; additional settings allow choice of which sensing technologies hold ON or retrigger lighting;

.4 colour matched lens and low profile design;

.5 wide dispersion lens area coverage, extending out up to 10 m (35') and area of 37 m^2 (400 ft^2);

.6 infrared and ultrasonic technologies;

.7 adjustable time delays and sensitivity;

.8 manual pushbutton operation (override);

.9 low voltage or line voltage operation to suit specific applications;

.10 complete with required mounting accessories.

.8 DW-200 Series dual technology occupancy sensors as follows:

.1 dual relay, infrared and ultrasonic technologies wall switch sensor for controlling 2 independent light loads/circuits;

.2 when both PIR and ultrasonic technologies detect occupancy, lights turn ON automatically; once lights are ON, detection by either technology holds lights ON until occupancy is no longer detected and time delay elapses;

.3 colour matched lens and low profile design;

.4 wide dispersion lens area coverage, extending out up to 10 m (35') and area of 37 m^2 (400 ft^2);

.5 adjustable time delays and sensitivity;

.6 manual pushbutton operation (override);

.7 selectable walk-through, test and presentation modes;

.8 low voltage or line voltage operation to suit specific applications;

.9 complete with required mounting accessories.

.9 For corridors or wide space coverage: Ceiling mounted, WT series, ultrasonic technology type sensors as follows:

.1 ultrasonic technologies;

.2 when ultrasonic technology detects occupancy, lights turn ON automatically; once lights are ON, detection holds lights ON until occupancy is no longer detected and time delay elapses;

.3 low voltage operation;

.4 corridor applications to include linear lens area coverage, extending out up to 13.5 m (45') in 2 directions;

.5 wider spaces applications to include wide dispersion coverage to suit space, up to 200 m^2 (2200 ft^2);

.6 low profile ceiling mounting design;

.7 integral light sensor;

.8 adjustable digital time delay;

.9 LED indication of occupancy detection;

.10 isolated relay for interconnection to auxiliary control systems where required.

.10 For outdoor control of lighting: Series "EW" outdoor motion sensor:

.1 weatherproof and raintight enclosure;

.2 operating temperature from minus 40°C to 54°C (-40°F to 130°F);

.3 adjustable head,

.4 with minimum 270° of coverage;

.5 adjustable light level from 5.4 lux to 2150 lux (0.5 fc to 200 fc);

.6 isolated relay with NO and NC outputs;

.7 13 mm (1/2") threaded conduit nipple for attachment to standard weatherproof electrical box with faceplate;

.8 voltage rating to suit application.

.11 Override switches to be wall mounting in single gang recessed outlet boxes.

.12 Day light sensors to be provided where required for dimming or controlling lights in areas of windows and atriums/sky lights.

.13 Where both normal and emergency power circuited luminaries exist, provide emergency power control unit that allows sensor to control both emergency power circuited luminaries as well as normal power circuited luminaries, and when normal power is lost, forces on emergency power circuited luminaries.

.14 Relays to be provided as required to integrate sensors to BAS. Coordinate exact requirements with central lighting control system vendor and BAS vendor.

.15 Wiring in conduit, mounting hardware and ancillary devices to be provided as per Manufacturer requirements.

.16 System to be complete with initial 1 year parts and labour warranty, with additional extended 5 years parts warranty.

.17 Include for and arrange for Manufacturer authorized representative to perform on site testing, verification and certification of installed system. Refer to Part 3 installation article for additional requirements.

.18 Where sensors are interconnected to dimming system, ensure that they are 100% compatible with respective control systems, dimmers and ballasts. Confirm with respective equipment manufacturers and obtain in writing that such integrations are acceptable to each manufacturer.

.19 Where devices are connected to central lighting control system, acceptable device manufacturers to be as recommended by manufacturers of central lighting control system.

.20 Generally, acceptable manufacturers are:

.1 Legrand-Watt Stopper;

.2 Hubbell (supplied by Omnilumen);

.3 Sensor Switch;

.4 Leviton;

.5 NX Lighting Controls;

.6 Acuity Brands Controls;

.7 Cooper Controls.

2.7 **DIGITAL LIGHTING CONTROLS**

.1 Legrand - Watt Stopper Inc., "DLM series" CSA approved devices to provide digital lighting management system for automatic control of lighting with exact series model number to suit specific applications as per system Manufacturer recommendations. Include for but not be limited to providing following components:

.1 controllers;

.2 dual technology occupancy sensors;

.3 controls and daylight sensors;

.4 power and slave packs;

.5 wiring in conduit and mounting hardware.

.2 **Digital Switches and Controllers:**

.1 No. LMRC-100 series room controllers as follows:

.1 ON/Off button for each load;

.2 includes one or two relays to switch a total of 20 amps, and high-efficiency switching power supply;

.3 room controllers switch lighting or motor loads in response to input from communicating devices;

.4 plenum rated;

.5 "Plug n'Go" automatic configuration;

.6 "Push n' Learn" configuration functionality;

.7 LED status indicators;

.8 with number of integral relays as required for applications not requiring dimming control;

.9 RJ45 connectors.

.2 No. LMRC-210 series room controllers as follows:

.1 ON/OFF/0-10 volt dimming button for each load;

.2 includes one, two or three relays to switch a total of 20 amps, high-efficiency switching power supply and one 0-10 volt output per relay for control of dimmable loads including electronic ballasts;

.3 room controllers dim or switch lighting or motor loads in response to input from communicating devices; when a dimming input is received, relay switches on when dimmed level rises above zero, and off when it reaches zero, to coordinate control of power and the 0-10 volt signal to load;

.4 monitors current draw of total connected load;

.5 plenum rated;

.6 "Plug n'Go" automatic configuration;

.7 "Push n' Learn" configuration functionality;

.8 LED status indicators;

.9 with 0-10 VDC dimming control signal; exact series number to suit specific application and number of integral relays as required;

.10 RJ45 connectors.

.3 No. LMSW-100 series switches as follows:

.1 ON/OFF low voltage buttons to control individual or multiple loads;

.2 IR transceiver for wireless configuration and control;

.3 LED status indicators;

.4 single gang decorator wall plates;

.5 configuration button for "Push n' Learn";

.6 with number of button switches as required;

.7 RJ45 connectors.

.4 No. LMDM-101 series low voltage digital dimming wall switch as follows:

.1 for dimming control of one or more lighting loads;

.2 to raise or lower light levels, recall a pre-set level and turn lights on or off;

.3 IR transceiver for wireless configuration and control;

.4 LED status indicators;

.5 LED bar graph to indicate light level;

.6 single gang decorator wall plates;

.7 configuration button for "Push n' Learn";

.8 RJ45 connectors.

.5 No. LMCT-100 series digital wireless configuration tool as follows:

.1 digital handheld wireless tool for remote configuration of system, that enables system and device modifications via pushbutton, without ladders or tools;

.2 configures sensors, switches, controllers;

.3 intuitive navigation pad provides interface for users to view current system parameters of system network and make changes by navigating through simple menus;

.4 adjustable occupancy sensor parameters include sensitivity, time delay and trigger modes;

.5 dimming parameters include low/high trim, pre-set level and lamp burn in time;

.6 daylighting adjustments include operating mode, setpoints, fade times and time delays;

.7 adjusts light level of dimmed loads;

.8 OLED screen;

.9 2-way IP communication via IR transceiver;

.10 Battery operated;

.11 Includes batteries, carrying case and belt clip.

.6 No. ELCU - 200 series emergency lighting control unit as follows:

.1 self-contained device that permits lighting control devices to control lighting fixtures connected to emergency power source as well as fixtures connected to normal power source;

.2 upon loss of normal power, unit functions to maintain operation of designated emergency lights or activates operation of connected emergency lights;

.3 push to test operation button feature;

.4 LED indication for emergency and normal power operation.

.3 **Digital Sensors:**

.1 For applications in general areas: Ceiling mounted, LMDC-100 digital, dual technology type sensors as follows:

.1 low voltage operating with 360° lens area coverage;

.2 low profile ceiling mounting design;

.3 combination passive infrared and ultrasonic technologies;
.4 "Plug n'Go" automatic configuration;
.5 "Push n' Learn" configuration functionality;
.6 IR transceiver;
.7 LED indicators;
.8 LCD display and pushbuttons for setup;
.9 integral light sensor;
.10 isolated relay for interconnection to auxiliary control systems if required;
.11 walk-thru and test mode functions;
.12 adjustable sensitivity and digital time delay;
.13 RJ45 connectors.

.2 For corner mount applications: LMDX-100 digital, dual technology type sensors as follows:
.1 low voltage operating with wide dispersion lens area coverage of 185 m^2 (2000 ft^2);
.2 passive infrared and ultrasonic technologies;
.3 "Plug n'Go" automatic configuration;
.4 "Push n' Learn" configuration functionality;
.5 IR transceiver;
.6 LED indicators;
.7 LCD display and pushbuttons for setup;
.8 walk-thru and test mode functions;
.9 adjustable sensitivity and digital time delay;
.10 mounting to wall box or using mounting plate directly to ceiling; refer to drawings and coordinate with Consultant;
.11 RJ45 connectors.

.3 For corner mount applications requiring various coverage: LMPX-100 digital, PIR technology type sensors as follows:
.1 connects to room controller to turn loads on and off based on occupancy; automatic configuration through system;
.2 low voltage operating with various lens with area coverage of high density, long range, 1 or 2-sided aisle;
.3 passive infrared technologies;
.4 "Plug n'Go" automatic configuration;
.5 "Push n' Learn" configuration functionality;
.6 IR transceiver;
.7 LED indicators;
.8 LCD display and pushbuttons for setup;
.9 walk-thru and test mode functions;
.10 adjustable sensitivity and digital time delay;
.11 mounting to wall box or using mounting plate directly to ceiling; refer to drawings and coordinate with Consultant;
.12 RJ45 connectors.

.4 LMLS-500 series switching and dimming photo sensor as follows:
.1 multi-zone (3) switching and dimming open loop digital photo sensor;

.2 monitors the daylight contribution through a window or skylight and works with room controller to maintain design light levels in each lighting zone;

.3 daylight responsive on/off, bi-level, tri-level or dimming control;

.4 60 degree spatial response;

.5 IR transceiver for wireless configuration and control;

.6 "Plug n'Go" automatic configuration;

.7 LED status indicators;

.8 RJ45 connectors.

.5 LMIO-101 digital input/output interface:

.1 allows seamless integration with third party devices to provide additional functionality in digital lighting management system;

.2 Plug n' Go configuration;

.3 Push n' Learn functionality for personalizing system settings to accommodate application needs

.4 self-contained switching power supply and relay system

.5 five status LEDs and configuration LED;

.6 Hold-on/Hold-off, occupancy sensor, time clock, load shed, cleaning switch and key switch modes available through DIP switch configurations;

.7 over-current protection;

.8 plenum rated.

.6 Low Voltage Switches:

.1 LVS-1 series low voltage, quiet, single-pole, double throw momentary contact switch used with low voltage lighting control panels;

.2 appearance matches conventional toggle switches and fits standard switch plate openings;

.3 key operated type where required.

.7 Fire alarm interface module to interconnect fire alarm such that activation of fire alarm will initiate lighting control system to go into emergency sequence, typically raising dimmed lighting to full brightness and returning lighting levels back to levels before fire alarm event;

.8 Additional system interfaces, modules and connectors as required to integrate other components to provide a complete system.

.9 Include no. LMRJ series pre-terminated cables and segment network wire, and junction boxes as required completing system connections.

.10 Power packs to be self-contained, 347/120VAC/24VDC (or of voltage shown on drawings) transformer relay system. Slave packs to contain isolated relay. System to allow one sensor to control luminaires circuited to both essential power circuits and normal power circuits.

.11 Override switches to be wall mounting in single gang recessed outlet boxes.

.12 Day light sensors to be provided where required to dim or control lights in areas of windows and atriums/sky lights.

.13 Provide wiring, mounting hardware, connectors, jacks, and ancillary devices as per Manufacturer requirements. Wiring to be typically minimum CAT 5e unshielded twisted pair conductors terminated with RJ45 connectors. Comply with Manufacturer installation requirements. Submit block wiring diagram of system as part of shop drawings.

.14 System to be complete with initial 1 year parts and labour warranty, with additional extended 5 years parts warranty.

.15 Include costs for and arrange for Manufacturer authorized representative to perform on site testing, verification and certification of installed system. Refer to Part 3-Installation article for additional requirements.

.16 Where sensors are interconnected to dimming system, ensure that they are 100% compatible with respective control systems, dimmers and ballasts. Confirm with respective equipment manufacturers and obtain in writing that such integrations are acceptable to each manufacturer.

.17 Acceptable manufacturers are:

.1 Legrand-Watt Stopper;
.2 Hubbell (supplied by Omnilumen);
.3 Sensor Switch;
.4 Leviton;
.5 NX Lighting Controls;
.6 Acuity Brands Controls;
.7 Cooper Controls.

2.8 LOW VOLTAGE LIGHTING RELAYS & SWITCHES

.1 Legrand Watt Stopper, CSA approved, factory tested relays and associated devices for low voltage lighting control, as follows:

.1 specification grade, heavy duty, 20 ampere rated plug-in relays complete with auxiliary contacts to provide status indication;
.2 24 V, momentary contact, switches, single, decorative styling, ivory pushbutton type with pilot and location light LEDs;
.3 24 V, momentary contact, switches, multi ivory pushbutton type with pilot and location light LEDs, and removable lens cap for labelling each switch with laminated tape;
.4 24 V, momentary contact, key operated switches complete with keys;
.5 24 V, momentary contact, ivory toggle type switches;
.6 decorative style, Lexan screwless wall plates;
.7 type 302 stainless steel wall plates, number of gang as required, suitable for switches specified and complete with mounting brackets and matching screws;
.8 power supplies sized as required;
.9 wiring in conduit, in accordance with system Manufacturer requirements;
.10 EEMAC 1, electrical box sized to accommodate system components and spare future 10%; identify box cover with engraved nameplate.

.2 Acceptable manufacturers are:

.1 Legrand Watt Stopper;
.2 NX Lighting Controls
.3 Douglas Power Equipment Ltd.;
.4 Hubbell Automation;
.5 Lutron Electronics;
.6 Leviton;
.7 Acuity Brands Controls;
.8 Cooper Controls.

2.9 **LOW VOLTAGE LIGHTING CONTROL PANELS**

.1 Legrand Watt Stopper, CSA approved, factory pre-wired, assembled and tested panels for low voltage lighting control.

.2 Components to include but not be limited to following:

.1 NEMA 1 enamelled painted steel tub, with hinged, key lockable, surface or flush mounting cover and drip shield (for surface mounted panels);

.2 interiors consisting of motherboard with relay LED status indication, colour coded connections, card slots and barrier to separate voltage levels;

.3 sized suitable for up to forty-eight (48) relays as required;

.4 specification grade, heavy duty, 20 ampere rated plug-in relays complete with auxiliary contacts to provide status indication;

.5 power supplies sized as required;

.6 colour coded and labelled terminals with push-on connections;

.7 panel identification card in plastic pouch affixed inside of cover;

.8 barrier for separation of high voltage (class 1) and low voltage (class 2) wiring;

.9 screwless, removable plug-in connections for low voltage terminations;

.10 DIN rail mounted contactors, NO or NC as required and compatible with and of rating to suit lighting, ballasts and loads being connected and controlled;

.11 power supply as required to supply sufficient power to system components;

.12 master ON/OFF group switching card to sequence any number of relays in a panel ON or OFF without requiring handheld device or special programming tools; pushbutton controls with LED indicators to be provided for group operation and status;

.13 provide individual direct overrides for each relay or per group as zoned on drawings;

.14 24 V, momentary contact, switches, single, decorative styling, ivory pushbutton type with pilot and location light LEDs;

.15 24 V, momentary contact, switches, multi ivory pushbutton type with pilot and location light LEDs, and removable lens cap for labelling each switch with laminated tape;

.16 24 V, momentary contact, key operated switches complete with keys;

.17 24 V, momentary contact, ivory toggle type switches;

.18 decorative style, Lexan screwless wall plates;

.19 type 302 stainless steel wall plates, number of gang as required, suitable for switches specified and complete with mounting brackets and matching screws;

.20 wiring in conduit, in accordance with system Manufacturer requirements;

.21 programming and interfacing module cards for integration to BAS to suit required system sequence of operation of lighting circuits;

.22 sequence of operation to suit specific applications as confirmed with Consultant.

.3 Supply with shop drawings, detailed wiring diagrams, and floor plans identifying lighting controls and lighting panels being integrated to and any mechanical systems interconnections.

.4 System panels to be sized to accommodate 10% future components.

.5 Acceptable manufacturers are:

.1 Legrand Watt Stopper;

.2 NX Lighting Controls

.3 Douglas Power Equipment Ltd.;
.4 Hubbell Automation;
.5 Lutron Electronics;
.6 Leviton;
.7 Acuity Brands Controls;
.8 Cooper Controls.

2.10 **LOW VOLTAGE LIGHTING CONTROL SYSTEM**

.1 Legrand Watt Stopper, CSA approved, automatic lighting control system and integrated factory pre-wired, assembled and tested panels for low voltage lighting control.

.2 WinControl system software and central programming computer terminal provides full system automation and control of panels. Software provides Windows compatible factory created custom colour screens and graphics with reports, schedules, operating conditions. Software allows user friendly programmable and automatic control of system panels and connected lighting circuits. Control station terminal includes:

.1 Pentium 4 class PC terminal complete with minimum 500 GB hard drive, minimum 512 MB RAM; exact terminal requirements to be as per system Manufacturer recommendations;
.2 Windows operating system software;
.3 DVD/CD/R/W drive;
.4 minimum 480 mm (19") LCD flat panel display monitor;
.5 PC connectivity, TCP/IP connections, historical and runtime accumulation, graphic programming and control;
.6 interface cards, I/O devices and connecting cables as required;
.7 other ancillary devices to provide a full and functional system.

.3 Additional system components to include but not be limited to following:

.1 NEMA 1 enamelled painted steel tubs for relay panels, with hinged, key lockable, surface or flush mounting cover and drip shield;
.2 panel interiors consisting of motherboard with relay LED status indication, colour coded connections, card slots and barrier to separate voltage levels;
.3 panels sized suitable for up to forty-eight (48) relays as required;
.4 specification grade, heavy duty, 20 ampere rated plug-in relays complete with auxiliary contacts to provide status indication;
.5 colour coded and labelled terminals with push-on connections;
.6 panel identification card in plastic pouch affixed inside of cover;
.7 barrier for separation of high voltage (class 1) and low voltage (class 2) wiring;
.8 screwless, removable plug-in connections for low voltage terminations;
.9 DIN rail mounted contactors, NO or NC as required and compatible with and of rating to suit lighting, ballasts and loads being connected and controlled;
.10 power supply as required to supply sufficient power to system components;
.11 master ON/OFF group switching card to sequence or any number of relays in a panel ON/OFF without requiring handheld device or special programming tools; pushbutton controls with LED indicators to be provided for group operation and status;
.12 individual direct overrides to be provided for each relay or per group as zoned on drawings;
.13 group switching card;

.14 interface modules, network clock, photocontrol package as required to provide automatic control, distributed processing and communications with central system control software, other panels and Mechanical Division building automation system;

.15 24 V, momentary contact, switches, single, decorative styling, ivory pushbutton type with pilot and location light LEDs;

.16 24 V, momentary contact, switches, multi ivory pushbutton type with pilot and location light LEDs, and removable lens cap for labelling each switch with laminated tape;

.17 24 V, momentary contact, key operated switches complete with keys;

.18 24 V, momentary contact, ivory toggle type switches;

.19 decorative style, Lexan screwless wall plates;

.20 type 302 stainless steel wall plates, number of gang as required, suitable for switches specified and complete with mounting brackets and matching screws;

.21 wiring in conduit, in accordance with system Manufacturer requirements;

.22 programming and interfacing module cards for integration to BMS to suit required system sequence of operation of lighting circuits;

.23 confirm sequence of operation with Consultant.

.4 System panels to be sized to accommodate 20% future components.

.5 Supply with shop drawings, detailed wiring diagrams and floor plans identifying lighting controls and lighting panels being integrated to and any mechanical systems interconnections. Include sample proposed graphic displays with shop drawing submission. Final sequence of operation and layout of graphics to be approved by Consultant prior to start of Work.

.6 Acceptable manufacturers are:

.1 Legrand Watt Stopper;

.2 NX Lighting Controls

.3 Douglas Power Equipment Ltd.;

.4 Hubbell Automation;

.5 Lutron Electronics;

.6 Leviton;

.7 Acuity Brands Controls;

.8 Cooper Controls.

2.11 **DIMMING SYSTEM PROVISIONS**

.1 Supply and installation of dimming system is part of Work of Division 11. Issued separately, are documents identifying electrical requirements to be provided by Electrical Contractor. Obtain such documents from Consultant and include for respective work.

.2 Be responsibilities for, but not be limited to, providing following items to accommodate installation of dimming system:

.1 system conduit;

.2 system device backboxes;

.3 system grounding requirements;

.4 system feeder requirements;

.5 coordination of conduit, box and system power requirements with Division 11 successful system tenderer;

.6 installation of control cables as specified in Division 11.

.3 For product general specifications, refer to respective sections for products, requirements of Division 11 and/or issued drawings.

2.12 **DIMMING CONTROL STATION**

.1 Dimming system to be based on Lutron Electronics Co. "Grafik Eye _____" series system, CSA approved, ULC listed and labelled dimming control including but not limited to following:

.1 dimmer of solid state construction;

.2 power booster/interfaces, where required;

.3 fire alarm interface;

.4 control stations of flush wall mounting type, with front panel control setting soft switch sliders and pre-set controls.

.2 For this application, all controls, dimmers, power supply are to be integrated into single wall mounted station.

.3 Dimming system incorporates a microprocessor based, fully integrated lighting control. General component requirements are shown on drawings.

.4 Control station to be flush wall mounting unit with faceplates free of visible fasteners and of finish to Consultant's approval. Stations to be provided with OFF pushbuttons and LED indicators. OFF function to be programmable pre-set with fade times. Station to be complete with infrared receiver compatible with wireless infrared remote control supplied with system. Station includes feature to prevent unauthorized alteration to pre-sets and fade times. Station includes flip open front cover. Finish of cover and base to be selected from Manufacturer standard options and confirmed with Consultant prior to ordering.

.5 Control station units provide multiple pre-set lighting scenes (minimum 4). Control to be capable of storing an additional pre-set lighting scenes which can be accessed via remote wall stations and/or control interfaces. Station to include minimum ____ zones of circuiting and control. Pre-set to be set via easy-to-use raise/lower switches, one raise and lower switch per zone. Intensity for each zone to be indicated via an illuminated barograph, one barograph per zone. More than one zone may be proportionately raised or lowered at same time. Programming of pre-set scenes to be accomplished without use of an 'enter' or 'store' button. Additionally, one or more zones may be temporarily overridden without altering scene values, which are stored in memory.

.6 Lighting levels to fade smoothly between scenes at time intervals of 0 to 59 seconds or 1 to 60 minutes. Fade time to be separately selectable for each scene and to be indicated by a digital display for current scene. Pressing a scene select button will illuminate corresponding scene LED and simultaneously begin changing barograph levels to reflect currently selected scene. In event that a pre-set scene with a fade time greater than 5 seconds is initially selected from an 'off' condition, programmed fade time to be temporarily overridden, unless otherwise noted, and lights to fade up to that scene over a five-second time span.

.7 Panel processor to provide following programming capability:

.1 electronically assign each circuit to any zone in dimming system;

.2 adjust High-End Trim and Low-End Trim;

.3 determine load type for each dimmer;

.4 determine Normal / Emergency function of panel and set emergency lighting levels;

.5 panel processor to react to changes from control in no more than 20 milliseconds (Update rate of 50 times per second);

.6 sequence of operation as confirmed with Consultant prior to start of Work.

.8 Upon loss of normal input power, a station operating from an emergency feed to immediately turn circuits within that station to full-on condition when emergency input power is present.

.9 Under Emergency input power feed, unless otherwise indicated dimmers to operate at 100% of dimmer output voltage. Under these conditions, dimmers will be in full-on state.

.10 Under Emergency input power feed, control stations to be inoperable. Once normal power is restored, lighting zones to revert back to their status prior to emergency condition without requiring any action on part of user.

.11 Illumination levels to be field-programmable to meet local code requirements for Emergency power conditions. Such options include, but are not limited to, providing a constant minimal light level for emergency circuits during normal operation or providing full function dimming under emergency power.

.12 Dry contact closures (momentary contacts for "ON" and "OFF") from fire alarm system to force selected dimmers to go to full. This function to be selectable on a dimmer by dimmer basis and to be processor independent.

.13 **Dimmer Modules:**

.1 Under fully-loaded operating conditions, dimmer modules to operate at a minimum 20°C (36°F) safety margin below component Manufacturer maximum component temperature rating at a 40°C (104°F) ambient room temperature. A positive air gap switch to be employed by each dimmer in panel to ensure that load circuits are open when "off" function is selected from control system. Dimmer to be capable of withstanding inrush current of 50 times operating current typically generated by a full circuit of switching electronic non-dim ballasts. Each dimmer to compensate for incoming line voltage variations such as changes in RMS voltage, frequency shifts, harmonics and line noise. Dimmer to be capable of maintaining constant light level with no visible flicker under ±2% change in RMS voltage/cycle or ±2 Hz change in frequency/second.

.2 Dimmer output voltage to be a minimum 95% of input voltage at maximum intensity setting under full load conditions. Each dimmer to incorporate an electronic "soft-start" default at initial turn-on that smoothly ramps lights up to appropriate levels within 0.5 seconds. Dimmer to be both designed and tested to withstand surges, without impairment to performance, of 6000V, 3000A (equivalent to a near lightning strike) as specified by ANSI/IEEE std. C62.41. One type of dimmer to be used for sources, line voltages, and frequencies.

.3 Filtering to be provided for each dimmer such that current rise to be at least 350 µsec as measured from 10%-90% of load current waveform and at least 525 µsec as measured from 0%-100% of load current waveform at 50% rated dimmer capacity at a 90° conduction angle. Current rise to be at least 400 µsec as measured from 10%-90% of load current waveform and at least 600 µsec as measured from 0%-100% of load current waveform at 100% rated dimmer capacity at a 90° conduction angle.

.4 Dimmers to operate sources/load types as required and connected, with a smooth continuous Square Law dimming curve or on a non-dim basis. Dimmers to be electronically assigned to appropriate load type/dimming curve and can be reassigned at any time.

.5 Dimmers to be suitable for dimming required connected lamp types including linear florescent compact fluorescent, incandescent and LEDs, as required.

.14 **Power Boosters and Interfaces:**

.1 2-way interfaces between system and AV systems; coordinate exact requirements with AV vendor;

.2 interface between system and fire alarm system; coordinate exact requirements with fire alarm vendor;

.3 interfaces to dim or switch specific types of loads;

.4 power boosters as required to increase zone capacity to accommodate connected loads.

.15 **Submittals:**

.1 Provide detailed design installation drawings of systems and include with shop drawings.

.2 Provide dimming load schedules and interconnection wiring diagrams.

.16 **Manufacturer Services:**

.1 Manufacturer authorized technician to provide following:

.1 custom system programming;

.2 inspection of installed system;

.3 adjustments;

.4 start-up procedures;

.5 certify system equipment and operation.

.17 Acceptable Manufacturers are:

.1 Lutron Electronics (647-388-5150);

.2 Electronic Theatre Control (as distributed by Omnilumen 905-886-8454);

.3 Philips (Strand) (905-294-9570);

.4 Acuity Brands Controls;

.5 Cooper Controls.

2.13 **DIMMING SYSTEM**

.1 Dimming system to be based on Lutron Electronics Co. "Grafik Eye _____" series system, CSA approved, ULC listed and labelled modular components including but not limited to following:

.1 dimmer modules of solid state construction;

.2 power booster/interfaces;

.3 fire alarm interface;

.4 control stations of flush wall mounting type, with soft switch sliders and pre-set controls.

.2 Dimming system incorporates a microprocessor based, fully integrated lighting control, utilizing digital multiplexed communications between remote stations, central processor, and load control devices (dimmers and relays) as required. General component requirements are shown on drawings.

.3 Control units provide multiple pre-set lighting scenes and 'off' for minimum _____ control zones. Control to be capable of storing an additional ____pre-set lighting scenes which can be accessed via wall stations and/or control interfaces. Up to ___ zones may be tied together in one system by linking control units. Pre-set to be set via easy-to-use raise/lower switches, one raise, and lower switch per zone. Intensity for each zone to be indicated via an illuminated barograph, one barograph per zone. More than one zone may be proportionately raised or lowered at same time. Programming of pre-set scenes to be accomplished without use of an 'enter' or 'store' button. Additionally, one or more zones may be temporarily overridden without altering scene values, which are stored in memory.

.4 Lighting levels to fade smoothly between scenes at time intervals of 0 to 59 seconds or 1 to 60 minutes. Fade time to be separately selectable for each scene and to be indicated by a digital display for current scene. Pressing a scene select button will illuminate corresponding scene LED and simultaneously begin changing barograph levels to reflect currently selected scene. In event that a pre-set scene with a fade time greater than 5 seconds is initially selected from an 'off' condition, programmed fade time to be temporarily overridden, unless otherwise noted, and lights to fade up to that scene over a five-second time span.

.5 Panel processor to provide following programming capability:

.1 electronically assign each circuit to any zone in dimming system;

.2 adjust High-End Trim and Low-End Trim;

.3 determine load type for each dimmer;

.4 determine Normal / Emergency function of panel and set emergency lighting levels;

.5 panel processor to react to changes from control in no more than 20 milliseconds (Update rate of 50 times per second);

.6 sequence of operation as confirmed with Consultant prior to start of Work.

.6 Upon loss of normal input power, a panel operating from an emergency feed to immediately turn circuits within that panel to full-on condition when emergency input power is present.

.7 Under Emergency input power feed, unless otherwise indicated dimmers to operate at 100% of dimmer output voltage. Under these conditions, dimmers will be in full-on state.

.8 Under Emergency input power feed, local control stations to be inoperable. Once normal power is restored, lighting zones to revert back to their status prior to emergency condition without requiring any action on part of user.

.9 Illumination levels to be field-programmable to meet local code requirements for Emergency power conditions. Such options include, but are not limited to, providing a constant minimal light level for emergency circuits during normal operation or providing full function dimming under emergency power.

.10 Dry contact closures (momentary contacts for "ON" and "OFF") from fire alarm system to force selected dimmers to go to full. This function to be selectable on a dimmer by dimmer basis and to be processor independent.

.11 Control Stations and Accessories:

.1 Faceplates free of visible fasteners and of finish to Consultant's approval.

.2 Model SG4SN-WH, which include controls for multiple zones and be with touch button sliders and pre-sets. Up to four (4) scenes of programmed pre-sets to be provided. Stations to be provided with ON, OFF and Take Control pushbuttons and LED indicators. ON and OFF functions to be programmable pre-sets with fade times. Master slider to be used for setting fade time. Station to be complete with infrared receiver compatible with wireless infrared remote control supplied with system.

.3 Control functions for each station to be assigned to pushbuttons, sliders and remote inputs or templates. There are to be multiple templates per control station which can be recalled via appropriate control function, Macro or automatically using astronomical time clock.

.4 Feature to prevent unauthorized alteration to pre-sets and fade times.

.5 Flush mounted multi-button stations for control of pre-set levels for scenes and include off control.

.6 RS 232 interface.

.12 **Dimmer Modules:**

.1 Under fully-loaded operating conditions, dimmer modules to operate at a minimum 20°C (36°F) safety margin below component Manufacturer maximum component temperature rating at a 40°C (104°F) ambient room temperature. A positive air gap switch to be employed by each dimmer in panel to ensure that load circuits are open when "off" function is selected from control system. Dimmer to be capable of withstanding inrush current of 50 times operating current typically generated by a full circuit of switching electronic non-dim ballasts. Each dimmer to compensate for incoming line voltage variations such as changes in RMS voltage, frequency shifts, harmonics and line noise. Dimmer to be capable of maintaining constant light level with no visible flicker under ±2% change in RMS voltage/cycle or ±2 Hz change in frequency/second.

.2 Dimmer output voltage to be a minimum 95% of input voltage at maximum intensity setting under full load conditions. Each dimmer to incorporate an electronic "soft-start" default at initial turn-on that smoothly ramps lights up to appropriate levels within 0.5 seconds. Dimmer to be both designed and tested to withstand surges, without impairment to performance, of 6000 V, 3000 A (equivalent to a near lightning strike) as specified by ANSI/IEEE std. C62.41. One type of dimmer to be used for sources, line voltages, and frequencies.

.3 Filtering to be provided for each dimmer such that current rise to be at least 350 microsecond as measured from 10%-90% of load current waveform and at least 525 microsecond as measured from 0%-100% of load current waveform at 50% rated dimmer capacity at a 90° conduction angle. Current rise to be at least 400 µsec as measured from 10%-90% of load current waveform and at least 600 µsec as measured from 0%-100% of load current waveform at 100% rated dimmer capacity at a 90° conduction angle.

.4 Dimmers to operate sources/load types as required and connected, with a smooth continuous Square Law dimming curve or on a non-dim basis. Dimmers to be electronically assigned to appropriate load type/dimming curve and can be reassigned at any time.

.13 **Power Boosters:**

.1 Power boosters to be provided to increase single zone load capacity as required for specific loads and applications.

.14 **Submittals:**

.1 Provide detailed design installation drawings of systems and include with shop drawings.

.2 Provide dimming load schedules and interconnection wiring diagrams.

.15 **Manufacturer Services:**

.1 Manufacturer Authorized Technician to provide following:

.1 custom system programming;
.2 inspection of installed system;
.3 adjustments;
.4 start-up procedures;
.5 certify system equipment and operation;
.6 instructions on system operating and maintenance.

.16 Acceptable Manufacturers are:

.1 Lutron Electronics (647-388-5150);
.2 Electronic Theatre Control (as distributed by Omnilumen 905-886-8454);
.3 Philips (Strand).
.4 Acuity Brands Controls;
.5 Cooper Controls.

2.14 CENTRAL DIMMING SYSTEMS

.1 Central dimming system to be based on Lutron Electronics Co. "Grafik 7000/QS" series system, consisting of CSA approved, ULC listed and labelled modular components including but not limited to following:

.1 dimmer modules and relays;
.2 power/control/switching panels;
.3 power interfaces;
.4 power modules;
.5 centralized control system software, processor and terminals/servers;
.6 control stations of flush wall mounting type, with soft switch sliders and pre-set controls;
.7 interfaces to other systems;
.8 sensors;
.9 shade controllers and power supplies;
.10 wiring in conduit and ancillary devices.

.2 System to integrate to local Grafik QS/3000/4000 series units to allow for local controls in designated meeting rooms and other areas as required. These stations to connect to central system in manner to allow users to locally bypass centrally pre-set lighting levels. Required series type to suit room applications in number of zones, scenes and pre-sets, and load capacities.

.3 Dimming systems incorporate a microprocessor based, fully integrated lighting control, utilizing digital multiplexed communications between remote stations, central processor and load control devices (dimmers and relays) as required. General component requirements are typically shown on drawings.

.4 Lighting levels to fade smoothly between scenes at time intervals of 0-59 seconds or 1-60 minutes. Fade time to be separately selectable for each scene and to be indicated by a digital display for current scene. Pressing a scene select button will illuminate corresponding scene LED and simultaneously begin changing barograph levels to reflect currently selected scene. In event that a pre-set scene with a fade time greater than 5 seconds is initially selected from an 'off' condition, programmed fade time to be temporarily overridden, unless otherwise noted, and lights to fade up to that scene over a 5 second time span.

.5 System processor to provide following programming capability:

.1 electronically assign each circuit to any zone in dimming system;

.2 adjust High-End Trim and Low-End Trim;

.3 determine load type for each dimmer;

.4 determine Normal/Emergency function of panel and set emergency lighting levels;

.5 panel processor to react to changes from control in no more than 20 milliseconds (Update rate of 50 times per second).

.6 Upon loss of normal input power, a panel operating from an emergency feed to immediately turn circuits within that panel to full-on condition when emergency input power is present. System to comply with CSA equivalent requirements to UL 1008.

.7 Under Emergency input power feed, unless otherwise indicated dimmers to operate at 100% of dimmer output voltage. Under these conditions, dimmers will be in full-on state.

.8 Under Emergency input power feed, local control stations to be inoperable. Once normal power is restored, lighting zones to revert back to their status prior to emergency condition without requiring any action on part of user.

.9 Illumination levels to be field-programmable to meet local code requirements for Emergency power conditions. Such options include, but are not limited to, providing a constant minimal light level for emergency circuits during normal operation or providing full function dimming under emergency power.

.10 Dry contact closures (momentary contacts for "ON" and "OFF") from fire alarm system to force selected dimmers to go to full. This function to be selectable on a dimmer by dimmer basis and to be processor independent.

.11 System Software: Custom programmed software to Operate on server or personal computer (PC) running latest Windows software. Various software functions include but are not limited to following:

.1 Real Time Tabular Control Software: Allow user in real time (instant changes and feedback to/from lighting system) to monitor and control aspects of lighting control system;

.2 Design and Configuration Software: Define, program, modify, and update lighting control system database;

.3 Real Time Scene Programming Software: Allow user in real time to recall, redefine, and save zone intensities for selected scene;

.4 User Administration Software: Allow building centralized lighting control system administrator to assign users specific user names and passwords;

.5 Real Time Single Event Scheduling Software: Allow user to make temporary scheduling changes from pre-programmed time-clock events in lighting control system database.

.12 System Terminals: Provide servers that are to be used for 24 hours per day, 7 days per week programming, monitoring, control, graphics, and data logging of centralized lighting control system. Servers to handle client machine request in multi-computer systems. Server to be of type as recommended by system manufacturer and as approved by Owner. Include for full station requirements with minimum 432 mm (17") LCD screen, keyboard, DVC/CD RW unit, sufficient memory storage, cables, etc.

.13 System Processor: To integrate control station devices, power panels, shades, lighting zone controllers, and external inputs into single customizable, multiple failsafe lighting control system, operable manually, automatically or through computer control. Includes power failure memory and system recovery.

.14 **Power/Control/Switching Panels:**

.1 CSA approved, ULC listed and labelled.

.2 Field wiring accessible from front of panel without need to remove dimmer assemblies or other components.

.3 Panels passively cooled via free-convection, unaided by fans or other means.

.4 Dimmers designed and tested to specifically control incandescent/tungsten, magnetic low voltage, electronic low voltage, neon/cold cathode, fluorescent dimming ballasts, and non-dim loads; dimmers to be ULC listed and labelled for each type.

.5 Utilize universal 16A continuous-use UL listed dimmer.

.6 Limit current rise time to minimum 350 µsec as measured from 10-90% of load current waveform and minimum 525 µsec as measured from 0-100% of load current waveform at 50% rated dimmer capacity at a 90° conduction angle. Current rise to be minimum 400 µsec as measured from 10-90% of load current waveform and minimum 600 µsec as measured from 0-100% of load current waveform at 100% rated dimmer capacity at a 90° conduction angle.

.7 Replacing dimmer/relay does not require re-programming of system or processor.

.8 Dimmers/relays to include diagnostic LED's to verify proper operation and assist in system troubleshooting.

.9 Size panels to allow for 20% space for future.

.15 **Control Stations and Accessories:**

.1 Control units to provide multiple pre-set lighting scenes and 'off' for required control zones. Control to be capable of storing additional pre-set lighting scenes which can be accessed via wall stations and/or control interfaces. Pre-set to be set via easy-to-use raise/lower switches, one raise, and lower switch per zone. Intensity for each zone to be indicated via an illuminated barograph, one barograph per zone. More than one zone may be proportionately raised or lowered at same time. Programming of pre-set scenes to be accomplished without use of an 'enter' or 'store' button. Additionally, one or more zones may be temporarily overridden without altering scene values, which are stored in memory.

.2 Control stations to have faceplates free of visible fasteners and of finish to Consultant's approval.

.3 Control stations to include controls for multiple zones and be with touch button sliders and pre-sets. Stations to also be provided with ON, OFF and Take Control pushbuttons and LED indicators. ON and OFF functions to be programmable pre-sets with fade times. Master slider to be used for setting fade time. Station to be complete with infrared receiver compatible with wireless infrared remote control supplied with system.

.4 Control functions for each station to be assigned to pushbuttons, sliders and remote inputs or templates. There are to be multiple templates per control station which can be recalled via appropriate control function, Macro or automatically using astronomical time clock.

.5 Stations to have feature to prevent unauthorized alteration to pre-sets and fade times.

.6 Wall stations to be flush mounted multi-button stations for control of pre-set levels for scenes and include off control.

.7 RS 232 interface.

.16 **Dimmers:**

.1 Under fully-loaded operating conditions, dimmers to operate at a minimum 20°C (36°F) safety margin below component Manufacturer maximum component temperature rating at a 40°C (104°F) ambient room temperature. A positive air gap switch to be employed by each dimmer in panel to ensure that load circuits are open when "off" function is selected from control system. Dimmer to be capable of withstanding inrush current of 50 times operating current typically generated by a full circuit of switching electronic non-dim ballasts. Each dimmer to compensate for incoming line voltage variations such as changes in RMS voltage, frequency shifts, harmonics and line noise. Dimmer to be capable of maintaining constant light level with no visible flicker under ±2% change in RMS voltage/cycle or ±2 Hz change in frequency/second.

.2 Dimmer output voltage to be a minimum 95% of input voltage at maximum intensity setting under full load conditions. Each dimmer to incorporate an electronic "soft-start" default at initial turn-on that smoothly ramps lights up to appropriate levels within 0.5 seconds. Dimmer to be both designed and tested to withstand surges, without impairment to performance, of 6000 V, 3000 A (equivalent to a near lightning strike) as specified by ANSI/IEEE std. C62.41. One type of dimmer to be used for sources, line voltages, and frequencies.

.3 Dimmers to operate sources/load types as required and connected, with a smooth continuous Square Law dimming curve or on a non-dim basis. Dimmers to be electronically assigned to appropriate load type/dimming curve and can be reassigned at any time.

.17 **Ancillary Devices:**

.1 Power boosters to be provided as required to increase single zone load capacity as required for specific loads and applications.

.2 Provide sensors, mounting hardware, wiring, etc., as required.

.18 **Submittals:**

.1 Provide detailed design installation drawings of systems and include with shop drawings. Confirm number of relays and panels and coordinate exact installation locations with Consultant.

.2 Provide dimming load schedules and interconnection wiring diagrams.

.19 **Manufacturer Services:**

.1 Manufacturer Authorized Technician to provide following:

.1 custom system programming;

.2 inspection of installed system;

.3 adjustments;

.4 start-up procedures;

.5 certify system equipment and operation;

.6 instructions on system operating and maintenance.

.2 Typically include for minimum 3 onsite visits to:

.1 provide above services;

.2 ensure that contractor is trained properly to install system;

.3 Train Owner staff on operation and maintenance of system.

.20 **Warranty:** Manufacturer warranty covering 2 years full parts and labour and eight (8) years limited parts warranty to repair and replace defective equipment.

.21 **Integration:** Where system is interconnected to other system and equipment, ensure that it is 100% compatible with respective control systems, relays, and ballasts. Confirm with respective equipment manufacturers and obtain in writing that such integrations are acceptable to each manufacturer.

.22 Acceptable Manufacturers are:

.1 Lutron Electronics Grafik 7000/QS (647-388-5150);

.2 Philips (Strand) (905-294-9570);

.3 Electronic Theatre Control (as distributed by Omnilumen 905-886-8454);

.4 Acuity Brands Controls;

.5 Cooper Controls.

2.15 CENTRAL LIGHTING CONTROL SYSTEM

.1 Central lighting control system provides central low voltage control of lighting in designated areas of building. System components are CSA approved, and/or ULC listed and labelled, microprocessor controllable to provide but not be limited to following functions:

.1 ON/OFF control of luminaires;

.2 dimming of luminaires;

.3 low voltage control through low voltage relay panels;

.4 group/zoned switching/control/dimming of luminaires;

.5 timed sequence of operations;

.6 logging of system operations and generation of reports;

.7 self-monitoring.

.2 System is based on Strand Lighting integrated lighting control system.

.3 System and Equipment Compatibility:

.1 Be responsible for ensuring that various systems, equipment and components (such as luminaire ballasts, occupancy sensors, relays, controllers, etc.), to which this system interconnects and/or integrates to, are fully 100% compatible and can fully communicate together.

.2 Provide as part of shop drawing submission, written confirmation from various interconnected and/or integrated systems that their respective products comply with compatibility requirements.

.4 Contact Low Voltage Relay Panel:

.1 Lighting control panel is fully digital, designed specifically for lighting control applications, and consists of 12, 24, 36, or 48 relays per panel. A secondary "slave" panel in each size is available, as required.

.2 Panel setup and pre-set data is fully user programmable on a per panel or system wide basis.

.3 Panel is wall-mount, dead front, substantially framed and enclosed with 16-gauge and formed steel panels. Panel components are properly treated, primed, and finished in fine texture, scratch resistant, silver powder coat paint.

.4 Dimensions of relay panels are not to exceed:

.1 12 relay panel: 100 mm deep, 533 mm high and 401 mm wide (4" x 21" x 15.8");

.2 24 relay panel: 100 mm deep, 556 mm high and 597 mm wide (4" x 21.9" x 23.5");

.3 36 and 48 relay panels: 100 mm deep, 976 mm high and 597 mm wide (4" x 38.4" x 23.5").

.5 Relay panels consist of a wall mount enclosure and a relay panel insert with electrical and electronic components preassembled. Wall mount enclosure may be shipped separately to permit wall mounting and conduit stub in. Relay sub panel is factory pre-wired and dressed. Provide and terminate feed, load, and control wiring on screw terminals fitted within panel.

.6 Cable entries for panels are on top of panel. Knockouts are available on sides of panel to simplify wiring.

.7 Terminations and internal wiring are accessible via a removable front cover panel. Processor Module is accessible for programming at all times.

.8 Power efficiency of relay panel is greater than 95% at full load.

.9 Panels are suitable for 60 Hz supplies and accept power feeds from 120 V, 208 V and 347 V power supplies with installation of a panel barrier included with each panel.

.10 Relay panel includes an internal power supply to support up to (16) 24 vdc control stations.

.11 A "Panic" facility feature closes selected relays if Processor Module is removed or fails. Relays are selected from panel processor. It is to also be possible to select "Panic" as follows:

.1 panel processor on front of panel selects "Panic" and "Normal" operation;

.2 remote maintained contact closure for Fire Alarm interface;

.3 two remote momentary contact closures for "Panic" and "Normal" respectively.

.12 System ground is made at a grounding lug in panel.

.13 Panel is rated for 14,000 AIC fault current at 277 V.

.14 Panel is NEMA 2 rated sprinkler-proof enclosure.

.15 Panel is suitable for surface or recess mounting.

.16 Panels to be equipped for emergency lighting applications.

.17 Main panel control electronics is housed in one Panel Processor Module (RPM). Panel control electronics is completely digital without employing any digital to analogue demultiplexing schemes.

.18 Panel setup and pre-set data is stored in a non-volatile manner and may be transferred to a replacement Panel Processor Module without losing data.

.19 Each Panel Processor Module includes a back-lit LCD display with a keypad for panel setup, pre-set control, testing, panel status, error and diagnostics.

.20 LEDs indicate "DMX512 Port A", "DMX512 Port B" (ShowNet), Vision.net control and Power.

.21 Panel Processor Module is permanently mounted inside panel. RPM provides necessary low voltage signal connections. RPM provides only point for contractor connection of signal cables and PANIC activation.

.22 DMX512 and RS485 communication ports and remote contact input connections are optically isolated from processor electronics by a minimum of 2,500 V RMS isolation.

.23 Panel Processor can select any of relay or outputs to be activated by PANIC function. PANIC function is activated or de-activated by one or more local or remote contact closures.

.24 Control electronics provide following control and communication inputs as standard:

.1 one optically isolated DMX512 control input;

.2 an RS485 control input for Vision.net architectural control. Vision.net is a control system comprised of architectural style panels for recording and playback of pre-sets in individual assigned "rooms".

.3 two programmable panic inputs;

.4 one RS232 Serial programming port for remote programming using PC based configuration software.

.25 System supports ShowNet Ethernet input to provide an additional input plus processor status monitoring and configuration.

.26 Panel electronics provides two levels of operator interface:

.1 local standard interface that includes six (6) menu keys and a bitmapped backlit LCD display to access standard system menus;

.2 remote configuration via personal computer using RS232 or ShowNet Ethernet data links.

.27 Processor control electronics has update rate better than 16 ms (60 Hz) or 20 ms (50 Hz).

.28 Panel processor includes a programmable astronomical time clock to permit programmed relay closures with a schedule of 128 events that may be programmed for days of week, specific dates and offsets from sunrise or sunset. System also supports daylight savings time adjustments.

.29 RPM also has capability to support single and double pole relays that may be mixed throughout panel.

.30 Contact panel status reporting to report following conditions/data:

.1 processor active;

.2 DMX512 Port A input fail.

.31 Control electronics provides following setup functions that are user programmable on a per panel or system wide basis:

.1 DMX512 Port A patch;

.2 ShowNet DMX512 patch;

.3 architectural patch for Vision.net control systems;

.4 Record Vision.net pre-sets for load pattern switching;

.5 occupancy sensor and photocell control inputs;

.6 clock events;

.7 set control input priority logic.

.32 DMX512 Port A and ShowNet patching supports a panel start address and individual relay patch. Architectural patch defines panel circuit/room/room channel relationship for Vision.net control systems.

.33 Control electronics provides a facility to disable output of any individual relay by switching relay off.

.34 Processor provides an architectural Vision.net control system pre-set capability of 8 pre-sets for each of up to 256 separate rooms.

.35 It is possible to load new panel operating software via Ethernet connection to relay panel. There is no requirement to turn power off to panel during loading of panel software. It is possible to load new panel operating software into processor, regardless of state of program storage.

.36 Relays are snap-in factory wired units in single or double pole configurations. Relays are designed for repeat operation with mechanically operated contacts. Relays may be operated locally with a manual over-ride.

.37 Power connections are made on compression screw terminals. Control signal connections are made via plug-in connectors at each module chassis.

.38 Load connections are made via compression screw terminals on a terminal block.

.39 Relays are rated for 120 V/230 V/277 V/347 V.

.40 Relays are capable of continuous operation at full rated load and rated for tungsten, LED, cold cathode, and HID loads.

.41 Each assigned relay has a programmable switching threshold between 1 and 99%.

.42 Relays have a local control switch to turn relay on for testing and diagnostic purposes.

.43 Relays are UL, ETL and cUL, cETL recognized.

.44 To supplement internal Power Supply, a supplemental Power Supply is be available to support up to twenty (20) additional control stations, and are supplied complete with an enclosure for wall mounting in dimmer/distribution room.

.5 Dimmer Cabinet:

.1 Dimmer cabinets are fully digital, designed specifically for lighting applications, and consist of 3 or 6 or 9 dimmer module spaces, depending on cabinet size. A secondary "slave" 3, 6 or 9-module expansion cabinet are available, where required.

.2 Cabinet setup and pre-set data are fully user programmable on a per cabinet or system wide basis.

.3 Dimmer cabinet is wall-mount, dead front, substantially framed and enclosed with 16-gauge, formed steel panels. Cabinet components are properly treated, primed, and finished in fine texture, scratch resistant, silver powder coat paint.

.4 Dimensions of cabinets are not to exceed:

.1 Small: 175 mm deep, 635 mm high and 800 mm wide (7" x 25" x 32");

.2 Medium: 175 mm deep, 1067 mm high and 800 mm wide (7" x 42" x 32");

.3 Large: 175 mm deep, 1575 mm high and 800 mm wide (7" x 62" x 32").

.5 System is convection cooled and fans are not be required. Systems requiring forced air-cooling are not acceptable.

.6 Over-temperature sensing is provided, and shuts down power modules until temperature falls to within acceptable limits.

.7 Cabinet is factory pre-wired and dressed. Provide and terminate feed, load and control wiring on screw terminals fitted within cabinet.

.8 Cable entries for cabinets are on top right side of cabinet. A removable service panel is provided.

.9 Terminations and internal wiring is accessible via a removable front cover panel. Processor Module is accessible for programming at all times.

.10 Power efficiency of dimmer cabinet is greater than 95% at full load.

.11 Cabinets are suitable for 60 Hz supplies of 120/240 VAC 3-wire + ground, 120/208 VAC 4-wire + ground, and contain any combination of up to 3 or 6 or 9 Power Modules of appropriate supply voltage.

.12 Power feed terminals accept following cable sizes:

.1 small Cabinet: #6 to #00 AWG;

.2 medium Cabinet: #6 to #350 AWG;

.3 large Cabinet: #6 to #350 AWG.

.13 Each 6 and 9 module dimmer rack supports a main breaker.

.14 Dimmer cabinet has an internal power supply to support up to (16) 24 vdc architectural control stations.

.15 A "Panic" facility feature turns selected dimmers on to full. Dimmers are selected from rack processor. It is also possible to select "Panic" as follows:

.1 one Remote contact closure for Fire Alarm interface;

.2 one remote contact closures for "Panic".

.16 System ground is made at a grounding lug in top of dimmer cabinet.

.17 Rack Processor includes provision to select any of a maximum of 96 dimmer outputs to be activated by PANIC function. PANIC function is activated or de-activated by one or more local or remote contact closures.

.18 Control electronics provides following control and communication inputs as standard:

.1 RS485 control input for Vision.net architectural control. Vision.net is a control system comprised of architectural style panels for recording and playback of pre-sets in individually assigned "rooms";

.2 Contact closures dedicated for:

.1 PANIC ON - Turns Panic On;

.2 FIRE ALARM - Turns Panic On.

.19 Rack electronics to provide a local interface that includes 6 menu keys and a bitmapped backlit LCD display to access standard system menus.

.20 Control electronics allows maximum output levels of individual dimmers to be adjusted, e.g. to compensate for load circuit voltage loss. Selected dimmer curve regulates so that curve is proportional to programmed maximum voltage.

.21 Processor supports an architectural Vision.net control system pre-set capability of 125 channels for each of 255 separate rooms with programmable fade times. Time resolution to be a minimum of one second.

.22 Power Modules are factory wired units of similar size and heavy duty metal construction, designed to be installed into cabinet as a self contained bolt-in assembly. A plastic Power Module chassis is not acceptable. Modules are finished in powder coat black paint.

.23 Power connections are be made on setscrew terminals. Control signal connections are made via plug-in connectors at each module chassis.

.24 Load connections are made via spring-cage terminals.

.25 Power Modules are suitable for 110/120 V or 277 V, 60 Hz and are ULC listed and labelled.

.26 Power efficiency of each power module is better than 97% at full load. Adequate heat sinking is provided.

.27 Each dimmer is protected by fully magnetic circuit breaker of appropriate capacity mounted on faceplate of dimmer cabinet. This protective device has a "must trip" rating of 125% of rated capacity and is rated for a minimum 10,000 Amp interrupting capacity. It is possible to use breaker as a dimmer disconnect device. Dimmers are ULC listed and labeled.

.28 A Linear Power, Square, S-Curve, Non-Dim, or Fluorescent response curve is assigned from Processor Module for each dimmer.

.29 In addition to a default fluorescent curve, a magnetic or electronic ballast option and programmable top and bottom set levels are available to further optimize curve for each fluorescent dimmer. A specific curve for use with Advance Mark X ballasts is provided.

.30 Under normal circumstances, fluorescent Power Modules use default response curve with adjustments under software control. Modules are provided for a wide range of two and three wire electronic and magnetic ballasts.

.31 Dimmers have a local control switch to turn dimmer on for testing and diagnostic purposes.

.32 Dimmer racks are shipped with a power module bypass installed. This bypass permit loads to be tested and operated from dimmer rack circuit breakers prior to installation of power modules. These jumpers are removed at system commissioning.

.33 Standard dimmer modules are available for operation on 120 or 208-volt power supplies and are offered in Quad 10,15, and 20 amp modules dual 15 and 20 amp modules.

.34 SCR Dimmers have an integral inductive toroidal filter designed to reduce rate of rise of current such that rise time does not exceed 350 µs at full load, measured between 10-90% of load current waveform at a 90° conduction angle.

.35 Each dimmer module offers microprocessor controlled over-current and short circuit protection and automatically shuts down in presence of these conditions. Resetting dimmer to zero from control system restores operation in event of a module shutdown.

.36 Dimmer controls a wide range of loads including dimmable electronic ballasts, LED's, conventional incandescent lamps. Audible noise is reduced through use of electronic phase control.

.37 Specific features of Fluorescent Dimmer Modules are as follows:

.1 fluorescent modules are available in dual 120/208 V 20 amp modules;

.2 fluorescent dimmers are suitable for dimming electronic or magnetic 3-wire ballasts as recommended by dimming manufacturer;

.3 a mechanical relay is provided for switching on cathode heater supply when control level is raised above zero;

.4 fluorescent dimmers have a "Bottom Set" to adjust cut-off point ensuring maximum range of stable performance for both fluorescent and cold cathode loads.

.6 Vision.Net Control System:

.1 System is a fully integrated digital lighting control system, utilizing digital communications between stations, and control devices (dimmers, relays, and DMX-512 controlled equipment) in system as required.

.2 System supports up to 255 rooms with a maximum of 127 control channels per room, Star wiring is supported using any number of available 4 port Vision Net data hubs. Any number of dimmers may be assigned to a room.

.3 Large scales systems consisting of multiple Vision.net networks may be linked using ShowNet Ethernet networks.

.4 No central processor is required.

.5 Each station is connected as an RS485 serial "daisy chain" using Belden 1583A Cat 5e cable.

.6 It is possible to change standard control stations at any location on data network without requiring additional wiring or alterations to wiring specification. Touchscreen stations require a separate power feed to operate station electronics.

.7 System supports a digital communications link for station configuration and set up. An RS232 station to be used for connecting a Personal Computer to Vision.net data network (A cable fitted with 9-way D-type connectors is supplied with Vision Net software for this purpose).

.8 Vision.net Designer software is a graphical set up and configuration programmed designed to operate under Windows XP and Windows Vista operating systems.

.9 An astronomical clock is available on any system touchscreens capable of being programmed to any geographical location in world. Clock executes any number of daily, weekly or date specific events at fixed times, or offset relative to sunset and sunrise.

.10 Each room is capable of having any combination or quantity of control stations. It is possible to change stations at any location by replacing it with a different station type, and modifying systems configuration file accordingly.

.11 Each room has 32 pre-sets available, regardless of number of rooms or number of channels within each room. Pre-sets are selected from control stations, or are "played back" automatically by time clock events. Each pre-set has its own programmable fade, delay and hold time and may be linked for sequential playback in a single sequence, or using system macros a continuous loop if required.

.12 Programmable delay, fade and hold times are available in following increments; instant, 1/4 sec., 1/2 sec., 1 sec., 2 sec., 3 sec., 5 sec., 7 sec., 10 sec., 15 sec., 30 sec., 1 min., 5 min., 15 min., 30 min., 1 hr.

.13 It is possible to allocate a name or label to every room, panel, station, pre-set and group in system.

.14 It is possible during system configuration to create Macros using system smart command keys that carry out a sequence of standard system commands. It is possible to execute these Macros from any control station pushbutton, remote input or, automatically using astronomical time clock. It is possible to assign any of system commands to any station pushbutton, external device input, timeclock event, or Macro step.

.15 In cases where an area is to be divisible for separate or combined control, it is possible to combine constituent rooms either manually or with automatic partition switches. Rooms are combined using "Join" mode of operation where each room to maintain its own pre-sets, levels and channels. "Joining" coordinates selection of pre-sets within combined rooms from any control station within those rooms.

.16 Following commands are programmable to any system button:

- .1 Pre-set Recall;
- .2 Raise;
- .3 Lower;
- .4 Toggle - On/Off;
- .5 Smart button commands including room combine, cross-room commands and commands to Palette series lighting controllers.

.17 System includes an output simulation mode allowing system designer to test configurations prior to system installation.

.18 Touchscreen configuration is supported with simple drag and drop commands. Touchscreen Vision.net commands are also available on Outlook VN control stations.

.19 Touchscreens with ShowNet network connections are also be configured to connect to Palette series control consoles or Network control devices.

.7 Vision.net Touchscreen Stations:

.1 Vision.net touchscreens are full colour displays - 254 mm (10") full VGA display.

.2 Each display supports multiple tabs to allow users to organize their displays to meet a wide range of applications. Tabs support following applications:

.1 programmable Sliders that can be scaled and programmed as both channel controls and submasters. Three fader sizes are available allowing system programmers to optimize number of faders displayed on screen for maximum flexibility;

.2 touchscreen buttons are available in a variety of sizes and shapes permitting system designers flexibility to allow buttons to define their function through shape and colour;

.3 displays, faders, buttons and tabs have text labels in a choice of fonts, sizes and colours;

.4 time clock display with full system programming.

.3 Systems with network connections to also support tabs with:

.1 Web Browser capability allowing access to Strand ShowNet network devices;

.2 remote control and monitoring access to Strand Lighting Palette, Light Palette and Rack Palette control consoles.

.4 Any screen can have a colour graphic background to permit a wide range of custom graphic options for system designers. Backgrounds may be any bit mapped image. Alternately backgrounds may be assigned a wide range of colours.

.8 Pre-set Control Stations:

.1 Control station face plates are free of visible fasteners and of aesthetic appearance.

.2 Station face plates are fabricated of 0.64 mm (0.025") aluminum with an aluminum die cast trim frame.

.3 Control stations are supplied in an off-white powder coat paint finish. Control station legends are printed in grey.

.4 On control stations with sliders, sliders have 45 mm (1.75") travel with grey slider knobs.

.5 Control station push buttons have grey button caps with long life red LED linear array indicators.

.6 Control stations have a unique address between 1 and 255 configured at initial system start up.

.7 Touchscreen stations are fully programmable and 254 mm (10") size.

.8 An Outlook VN control station may consist of up to 8 LED's, 8 push-buttons and sixteen (16) sliders.

.9 2 gang and larger control stations require flush mounted masonry ("ears-in") back boxes, with a minimum depth of 90 mm (3.5"). Back boxes must be grounded in accordance with local wiring practices to provide a discharge path to ground for static electricity.

.10 Single gang control stations require a standard 4" square J-box (i.e. Raco #231), a 102 mm (4") square extension (i.e. Raco #203) of sufficient depth to increase overall mounting depth to a minimum 90 mm (3.5"), and a 1 gang reducer ring with an inside opening of at least 76 mm high (2.94") and 51 mm wide (1.98").

.11 Control stations are supplied complete with a sub-plate which is screwed to flush mounting back box with screws provided. Sub-plate allows control station to be hinged into position and secured with hexagonal set screws on bottom edge of trim ring.

.12 1.6 mm (1/16") Allen key is provided with each station.

.13 It is not necessary to remove button caps or sliders, or to disassemble control station for installation.

.14 Touchscreen stations are available with surface and flush mount enclosures designed to simplify station mounting.

.15 Vision.net data line terminations are via a screw-terminal plug and socket to facilitate removing a control station while maintaining continuity of data network.

.9 Outlook VN Slider with Pushbutton Stations:

.1 Each station has a MANUAL (Take Control) button which gives control to manually operated channel sliders.

.2 An OFF button is also be provided where OFF represents one of 125 pre-sets in room to which station is assigned. Pre-set recalled by OFF button is programmed using configuration software.

.3 Stations are available with 3, 6, 9, 12, or 15 sliders plus a proportional master. It is possible to allocate several channels within a room to a single slider.

.4 Channels not allocated to a slider are to either go out or remain at previously selected pre-set level when MANUAL is selected according to configuration software.

.5 Sliders may also be configured in submaster mode allowing them to operate as group masters.

.6 Buttons may be programmed to over right their default settings. Each button may be assigned any of following functions:

.1 Pre-set Recall;

.2 Raise;

.3 Lower;

.4 Toggle - On/Off;

.5 Smart button commands including room combine, cross room commands and commands to Strand Lighting Light Palette and Rack Palette controllers.

.7 Each station to have a RECORD button which will allow current slider settings to be recorded into one of pre-sets available from local pushbuttons. Fade, Hold and Delay times for these pre-sets to remain unchanged by this record action.

.8 Within each room, MANUAL buttons can be configured to operate on a "last action takes precedence basis" where recalling a pre-set or pressing another MANUAL or TAKE CONTROL button will cancel current selection. During configuration procedure it is possible to select "Override" mode for each room. In this mode an active MANUAL button can be cancelled by toggle action. It is possible to define whether channels fade to OFF pre-set or return to previously selected pre-set when TAKE CONTROL is cancelled.

.10 Outlook VN Pushbutton Stations:

.1 Button stations are fully configurable.

.2 Each button may be assigned any of following functions:

.1 Pre-set Recall;

.2 Raise;

.3 Lower;

.4 Toggle - On/Off;

.5 Smart button commands including room combine, cross room commands and commands to Strand Lighting Light Palette and Rack Palette controllers.

.3 Each station stores active control information at all times. No central processor is required.

.11 Data Cable Specification:

.1 Vision.net stations Belden 1583A Cat 5 cable.

.2 DMX 512 Belden 9829.

.12 Environmental Conditions:

.1 Ambient temperature extremes: -10°C to 60°C (15°F to 140°F).

.2 Recommended ambient temperature: 18°C to 25°C (64°F to 77°F).

.3 Relative humidity: 10-90% non-condensing.

.13 Central Terminal Station:

.1 Provide a central terminal with PC, minimum 432 mm (17") LCD flat panel monitor, keyboard, mouse and required peripherals for a complete central monitoring and programming station for system. Terminal to be supplied with requirements as recommended by system manufacturer. Locate where directed by Owner.

.14 Additional items:

.1 Ancillary components as required to provide integrated low voltage lighting control system.

.2 System riser and connection drawings.

.3 Installation Instructions and a Programming Guide.

.15 Manufacturer Services:

.1 Manufacturer authorized technician to provide following:

.1 custom system programming;

.2 inspection of installed system;

.3 adjustments;

.4 start-up procedures;

.5 certify system equipment and operation.

.2 Typically include for minimum 3 onsite visits to:

.1 provide above services;

.2 ensure that contractor is trained properly to install system;

.3 Train Owner staff on operation and maintenance of system.

.16 Acceptable Manufacturers are:

.1 Philips (Strand) (905-294-9570);

.2 Lutron Electronics Grafik 7000/QS (647-388-5150);

.3 Acuity Brands Controls.

.4 Crestron;

.5 Cooper Controls.

Part 3 - Execution

3.1 **INSTALLATION OF OUTSIDE LIGHTING CONTROL**

.1 Provide a photo cell to switch designated outside lighting on, and time switch as required for programmed "off" control. Provide relays/contactors for control connections to multiple lighting loads. Refer to drawing details and notes for exact requirements. Provide required wiring in conduit and system connections to provide outside lighting control.

.2 Provide a photo cell to switch designated outside lighting on, and relay/contacts as required for programmed "off" control and override control via Mechanical Division BAS. Provide relays/contactors for control connections to multiple lighting loads. Refer to drawing details and notes for exact requirements. Provide required wiring in conduit and system connections to provide outside lighting control. Provide suitable contacts/relays/contactors and wiring in conduit to nearest BAS panel for interconnection as required.

.3 Provide a photo cell to switch designated outside lighting on and off. Refer to drawing details and notes for exact requirements. Provide relays/contactors for control connections to multiple lighting loads. Provide required wiring in conduit and system connections to provide outside lighting control.

.4 Install components in accordance with Manufacturer instructions to suit specific installation requirements.

.5 Flush mount photo cell in north exterior wall of building at a height to permit cleaning. Confirm exact location prior to roughing-in.

.6 Connect lighting circuits to photo cell and to time switch which will be located adjacent panelboard.

.7 When outside lighting control work is complete, test operation of control system and adjust as required.

.8 Confirm exact sequence of operation with Consultant prior to start of Work.

3.2 **INSTALLATION OF TIMERS**

.1 Provide timers to control lighting and other equipment as required and confirmed by Consultant.

.2 Exact type of timers to be verified by manufacturer/supplier to ensure proper compatibility to interconnected equipment and loads. Confirm with respective manufacturers.

.3 Install devices in accordance with Manufacturer instructions. Provide wiring in conduit. Provide required power connections and interconnection to luminaires, equipment, and power panels.

.4 Programme timers as per schedule confirmed with Owner and/or Consultant.

.5 Provide engraved nameplate identifying each timer.

.6 After installation, adjust, test, and verify operation.

3.3 **INSTALLATION OF WALL BOX DIMMERS**

.1 Provide flush wall box dimmers in locations and connect to control lighting as indicated. Confirm exact locations prior to roughing-in. Equip each dimmer with a faceplate. Confirm faceplate colour prior to ordering.

.2 Install components in accordance with Manufacturer instructions to suit specific installation requirements.

.3 Where identified, provide central enclosure cabinet for mounting dimmers within and connect complete. Clearly identify each dimmer and enclosure with engrave Lamacoid nameplates. Confirm exact nomenclature with Consultant prior to ordering.

.4 When installation is complete, check and test operation of each dimmer and adjust as required.

.5 Ensure that each dimmer is properly sized to suit connected load.

3.4 **INSTALLATION OF OCCUPANCY SENSORS**

.1 Provide occupancy sensors and daylight sensors and associated devices to control lighting in areas as required. Provide power packs as required with suitable voltage and power ratings.

.2 Exact type of occupancy sensors and type of lenses to be verified by manufacturer/supplier to ensure proper coverage in sensed areas only, and compatibility to interconnected systems. Confirm with respective manufacturers.

.3 Be responsible for providing, locating, and aiming appropriate sensors in correct location required for complete and proper volumetric coverage within range of coverage(s) of controlled areas per Manufacturer recommendations. Rooms to have 90-100% coverage to completely cover controlled area to accommodate occupancy habits of single or multiple occupants at any location within room(s). Locations and quantities of sensors shown and/or noted are illustrations only and should only be used as guidelines. Provide additional sensors if required to properly and completely cover respective room.

.4 Verify with Manufacturer factory authorized representative, exact type of sensor to be used in each area, placement of sensors and installation criteria, to best meet requirements of end user. Manufacturer representative should be consulted for more non-typical installation types. Ensure that sensors connected to dimming system are 100% compatible with dimming system.

.5 Where luminaires in rooms/areas are fed from normal and emergency power circuits, provide suitable relays and provisions to ensure that operation of luminaires on emergency power are maintained during loss of normal power.

.6 Proper judgement must be exercised in executing installation so as to ensure that best possible installation in available space and to overcome local difficulties due to space limitations or interference of structural components. Also provide, at Owner's facility, training necessary to familiarize Owner personnel with operation, use, adjustment, and problem solving diagnosis of occupancy sensing devices and systems.

.7 Install devices in accordance with Manufacturer instructions. Provide wiring in conduit. Provide required power connections and interconnection to luminaires and power panels. Provide manual switches to override control system in each area/room as shown.

.8 Confirm finishes of sensors with Consultant prior to ordering.

.9 Confirm mounting heights with Architect and manufacturer prior to roughing-in and installation.

.10 Adjust sensitivity and time delays to best suit Owner furniture layout drawings. Allow for minor adjustments of locations (1 m [3.3']) of sensors.

.11 After installation is complete, provide for Manufacturer authorized representative to inspect, test and verify system performance and installation.

.12 After completion of project and within 30 days after Owner has taken occupancy and furnishings are in place, provide for Manufacturer authorized representative to revisit site to test and make final adjustments.

.13 Refer also to testing and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

3.5 **INSTALLATION OF LOW VOLTAGE LIGHTING CONTROLS**

.1 Provide low voltage lighting components as required. Connect complete.

.2 Install components in accordance with Manufacturer instructions to suit specific installation requirements.

.3 Flush mount low voltage switches into wall mounted electrical boxes. Provide suitable mounting bracket and faceplate for each switch. Confirm finishes with Consultant prior to ordering.

.4 Install power supplies, transformers and relays in barriered electrical boxes/enclosures and locate adjacent to surface mounted panel boards to which lighting loads are connected or in accessible ceiling space above recessed mounted panel boards to which lighting loads are connected. Exact locations to be confirmed with Consultant prior to start of work.

.5 Locate locations of boxes on as-builts.

.6 Clearly label each box and label low voltage switching circuits.

.7 Refer also to testing and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

3.6 **INSTALLATION OF LOW VOLTAGE LIGHTING CONTROL PANELS**

.1 Provide factory assembled low voltage lighting panels as indicated on drawings and as specified to control lighting and also integrate to Mechanical Divisions BAS system. Refer to notes on drawings.

.2 Install components in accordance with Manufacturer instructions to suit specific installation requirements.

.3 Provide programming of panels in sequence which is to be confirmed with Consultant prior to start of work.

.4 Provide relay panels for both emergency power and normal power lighting loads being controlled. Initially install tubs during construction work and install interiors during finishing work. Locate panels with dimmer panels as required. Ensure that wall space is sufficient for proper access for service and maintenance as per code requirements. Advise Consultant where spacing is an issue. Provide power, control and communication wiring in conduit to each panel as required. Confirm exact wiring type and requirements with system manufacturer. Control/communication wiring to generally be daisy chained between panels.

.5 Flush wall mount low voltage switches where shown, complete with a mounting bracket and faceplate for each switch. Confirm finishes with Consultant.

.6 Locate panels adjacent to branch circuit panelboards to which lighting loads are connected. Clearly identify low voltage switching circuits.

.7 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

.8 Coordinate work with BAS vendor for required interconnections. Extend wiring in conduit to required interconnection to BAS panels. Typically terminate in junction box adjacent panel, leaving a loop of 3m (10') of un-terminated wiring for final termination by respective system vendors of Mechanical Divisions. Coordinate exact requirements with Mechanical Divisions. Where requested by Mechanical Divisions, provide conduit to terminate at Mechanical Divisions panel.

.9 Clearly label each panel and label low voltage switching circuits.

.10 Upon completion of installation, provide following:

.1 inspection, testing, and verification of panels;

.2 re-verification of failed or replaced components;

.3 signed verification report.

.11 Refer also to testing and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

3.7 INSTALLATION OF LOW VOLTAGE LIGHTING CONTROL SYSTEM

.1 Provide required components for low voltage control of lighting. Where required, integrate to Mechanical Divisions BAS system. Refer to notes on drawings.

.2 Install components in accordance with Manufacturer instructions to suit specific installation requirements.

.3 Provide system terminal in location as confirmed with Owner and/or Consultant prior to start of Work. Prepare sample software screens for submission as part of shop drawings. Provide custom programming of system in sequence which is to be confirmed with Owner and/or Consultant prior to start of Work.

.4 Provide relay panels for both emergency power and normal power lighting loads being controlled. Initially install tubs during construction work and install interiors during finishing work. Locate panels with dimmer panels as required. Ensure that wall space is sufficient for proper access for service and maintenance as per code requirements. Advise Consultant where spacing is an issue. Provide power, control, and communication wiring in conduit to each panel as required. Confirm exact wiring type and requirements with system manufacturer. Control/communication wiring to generally be daisy chained between panels.

.5 Confirm emergency sequence of operation with Consultant prior to start of Work and include required hardware and software and interfaces to other integrated systems. Coordinate interfaces with respective system vendors.

.6 Flush wall mount low voltage switches into recessed wall boxes, complete with a mounting bracket and faceplate for each switch. Confirm finishes with Consultant prior to ordering.

.7 Locate panels adjacent to branch circuit panelboards to which lighting loads are connected. Clearly identify low voltage switching circuits.

.8 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

.9 Coordinate work with BAS vendor for required interconnections. Extend wiring in conduit to required interconnection to BAS panels. Typically terminate in junction box adjacent panel, leaving a loop of 3m (10') of un-terminated wiring for final termination by respective system vendors of Mechanical Divisions. Coordinate exact requirements with Mechanical Divisions. Where requested by Mechanical Divisions, provide conduit to terminate at Mechanical Divisions panel.

.10 Clearly label each panel and label low voltage switching circuits.

.11 Upon completion of installation, provide following:

.1 inspection, testing and verification of system;

.2 re-verification of failed or replaced components;

.3 signed verification report.

.12 Refer also to testing and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

3.8 INSTALLATION OF DIMMING CONTROL STATION

.1 Install dimming systems for dimming control of lighting for areas as identified and confirmed with Consultant. Refer to details on drawings. Circuit dimmers as required and note that no circuits to be loaded greater than rating of dimmers.

.2 Install dimmer control station in locations as shown and as required. Provide required power source and connections. Connect normal power feeder and emergency power feeder as required. Interconnect system to BAS and fire alarming system as applicable.

.3 Integrate system to fire alarm system, BAS and other systems, as required. Extend wiring in conduit to required interconnection panels of systems. Typically terminate in junction box adjacent panel, leaving a loop of 3m (10') of un-terminated wiring for final termination by respective system vendors of Mechanical Divisions. Coordinate exact requirements with Mechanical Divisions. Where requested by Mechanical Divisions, provide conduit to terminate at Mechanical Divisions panel.

.4 Confirm emergency sequence of operation with Consultant prior to start of Work and include required hardware and software and interfaces to other integrated systems. Coordinate interfaces with respective system vendors.

.5 Include for and arrange for Manufacturer authorized representative to perform programming work. Final program features must be approved by Owner prior to start of Work.

.6 Install recessed, wall mounting control stations and wall box dimmers in locations as shown.

.7 ON/OFF pushbuttons and pre-set buttons to be fade into operation, not instant operation. Where applicable, set cleaning pre-sets to control circuits at levels as directed by Consultant.

.8 Luminaire ballasts to be dimmed are to be electronic dimmable types completely compatible with dimming system. Ensure compatibility in writing with respective product manufacturers. Coordinate requirements and connect complete as per Manufacturer instructions.

.9 Provide wiring in accordance with Manufacturer instructions and run wiring in conduit. Wiring to be oversized in accordance with Manufacturer instructions.

.10 Install components in accordance with Manufacturer instructions to suit specific installation requirements.

.11 Confirm exact locations of components prior to roughing-in.

.12 Confirm device finishes with Consultant prior to ordering.

.13 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

.14 Submit with shop drawings, detailed system wiring diagram and system riser diagram.

.15 Clearly label low voltage circuits.

.16 Upon completion of installation, provide following:

.1 inspection, testing and verification of system;

.2 re-verification of failed or replaced components;

.3 signed verification report.

.17 Testing to include check of operation of each dimmer and control station. Adjust and pre-set devices as required to meet Owner applications.

.18 Refer also to testing and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

3.9 **INSTALLATION OF DIMMING SYSTEMS**

.1 Install dimming systems for dimming control of lighting for areas as identified and confirmed with Consultant. Refer to details on drawings. Circuit dimmers as required and note that no circuits to be loaded greater than rating of dimmers.

.2 Install dimmer panels in locations as shown and as required. Ensure that panels are located to allow sufficient access as per code requirements. Provide required power source and connections to panels. Provide schedule of dimmers in plastic sleeve attached to panel. Connect normal power feeder and emergency power feeder as required. Provide relays as required. Interconnect system to BAS and fire alarming system as applicable.

.3 Integrate system to fire alarm system, BAS and other systems, as required. Extend wiring in conduit to required interconnection panels of systems. Typically terminate in junction box adjacent panel, leaving a loop of 3m (10') of un-terminated wiring for final termination by respective system vendors of Mechanical Divisions. Coordinate exact requirements with Mechanical Divisions. Where requested by Mechanical Divisions, provide conduit to terminate at Mechanical Divisions panel.

.4 Confirm emergency sequence of operation with Consultant prior to start of Work and include required hardware and software and interfaces to other integrated systems. Coordinate interfaces with respective system vendors.

.5 Include for and arrange for Manufacturer authorized representative to perform programming work. Final program features must be approved by Owner prior to start of Work.

.6 Install recessed, wall mounting control stations and wall box dimmers in locations as shown.

.7 ON/OFF pushbuttons and pre-set buttons to be fade into operation, not instant operation. Set cleaning pre-sets to control circuits at levels as directed by Consultant.

.8 Luminaire ballasts to be dimmed are to be electronic dimmable types completely compatible with dimming system. Ensure compatibility in writing with respective product manufacturers. Coordinate requirements and connect complete as per Manufacturer instructions.

.9 Provide wiring in accordance with Manufacturer instructions and run wiring in conduit. Wiring to be oversized in accordance with Manufacturer instructions.

.10 Install components in accordance with Manufacturer instructions to suit specific installation requirements.

.11 Confirm exact locations of components prior to roughing-in.

.12 Confirm device finishes with Consultant prior to ordering.

.13 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

.14 Submit with shop drawings, detailed system wiring diagram and system riser diagram.

.15 Clearly label each dimmer/panel and label low voltage circuits.

.16 Upon completion of installation, provide following:

.1 inspection, testing and verification of system;

.2 re-verification of failed or replaced components;

.3 signed verification report.

.17 Testing to include check of operation of each dimmer and control station. Adjust and pre-set devices as required to meet Owner applications.

3.10 **INSTALLATION OF CENTRAL LIGHTING CONTROL SYSTEM**

.1 Submit as part of shop drawings, detailed design drawings, single line drawing, block drawings, equipment literature cuts, station finishes, and proposed sequence of operation of entire integrated system. Confirm sequence with Owner prior to start of Work.

.2 Provide required components for low voltage control of lighting. Where required, integrate system such that dimming system and Mechanical Divisions BAS system can provide control as required. Refer to notes on drawings.

.3 Dimming control system components and programming to be integrated to occupancy sensors and daylight sensors to perform an integrated lighting control system that provides dimming and ON/OFF control of designated luminaires. Zoning and sequence of operations to be pre-programmed and user friendly in any program changes. Confirm exact zoning and proposed sequence of operation via shop drawings submission stage.

.4 Provide relay panels for both emergency power and normal power lighting loads being controlled. Initially install tubs during construction work and install interiors during finishing work. Locate panels with dimmer panels as required. Ensure that wall space is sufficient for proper access for service and maintenance as per code requirements. Advise Consultant where spacing is an issue. Provide power, control, and communication wiring in conduit to each panel as required. Confirm exact wiring type and requirements with system manufacturer. Control/communication wiring to generally be daisy chained between panels.

.5 Confirm emergency sequence of operation with Consultant prior to start of Work and include required hardware and software and interfaces to other integrated systems. Coordinate interfaces with respective system vendors.

.6 Flush wall mount low voltage switches and mount into recessed wall boxes, complete with a mounting bracket and faceplate for each switch. Confirm finishes with Consultant.

.7 Locate relay panels adjacent to branch circuit panelboards to which lighting loads are connected. Clearly identify low voltage switching circuits.

.8 Install dimming controls for areas as identified and confirmed with Consultant. Refer to details on drawings. Circuit dimmers as required and note that no circuits to be loaded greater than rating of dimmers.

.9 Install dimmer panels in locations as shown and as required. Ensure that panels are located to allow sufficient access as per code requirements. Provide required power source and connections to panels. Provide schedule of dimmers in plastic sleeve attached to panel. Connect normal power feeder and emergency power feeder as required. Provide relays as required. Interconnect system to BAS and fire alarming system as applicable.

.10 Include for and arrange for Manufacturer authorized representative to perform programming work and adjustments. Final program features must be approved by Owner.

.11 Install recessed, wall mounting control stations and wall box dimmers in locations as shown and as required.

.12 ON/OFF pushbuttons and pre-set buttons to fade into operation, not instant operation. Set cleaning pre-sets to control circuits at levels as directed by Consultant.

.13 Luminaire ballasts to be dimmed are to be electronic dimmable types completely compatible with dimming system. Ensure compatibility in writing with respective product manufacturers. Coordinate requirements and connect complete as per Manufacturer instructions.

.14 Provide wiring in accordance with Manufacturer instructions and approved Manufacturer system wiring diagrams and run wiring in conduit. Wiring to be oversized in accordance with Manufacturer instructions to compensate for voltage drop. Do not splice wiring between control stations or between dimmer/relay panels/racks.

.15 Install components in accordance with Manufacturer instructions to suit specific installation requirements.

.16 Confirm exact locations of components prior to roughing-in.

.17 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

.18 Integrate system to fire alarm system, BAS and other systems, as required. Extend wiring in conduit to required interconnection panels of systems. Typically terminate in junction box adjacent panel, leaving a loop of 3m (10') of un-terminated wiring for final termination by respective system vendors of Mechanical Divisions. Coordinate exact requirements with Mechanical Divisions. Where requested by Mechanical Divisions, provide conduit to terminate at Mechanical Divisions panel.

.19 Confirm device finishes with Consultant prior to ordering.

.20 Submit with shop drawings, detailed system wiring diagram and system riser diagram.

.21 Upon completion of installation, provide following:

- .1 inspection, testing and verification of system;
- .2 re-verification of failed or replaced components;
- .3 signed verification report.

.22 Testing to include check of operation of each relay panel, dimmer and control station. Adjust and pre-set devices as required to meet Owner applications.

.23 Provide engraved lamacoid identification nameplate for each station, panel and controller. Clearly label each dimmer/panel and label low voltage circuits.

.24 Confirm nomenclature with Consultant prior to ordering.

.3 Refer also to testing and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

.2 Section 26 28 23 - Disconnect Switches - Fused and Non-Fused

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide fuse performance data characteristics for each fuse type and size above 100 A. Performance data to include: average melting/time-current characteristics.

.3 Shop Drawings:

.1 Provide shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Ship fuses in original containers.

.2 Do not ship fuses installed in switchboard.

.3 Store fuses in original containers in storage cabinet moisture free location.

1.5 EXTRA MATERIALS

.1 Three spare fuses of each type and size installed above 600 A.

.2 Six spare fuses of each type and size installed up to and including 600 A.

Part 2 - Products

2.1 FUSES - GENERAL

.1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.

.2 Fuses: product of one manufacturer.

2.2 FUSE TYPES

.1 Class L fuses.

.1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.2 Type L2, fast acting. Class J fuses.

.3 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.4 Type J2, fast acting.

.2 Class R -R fuses.

.1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.

.2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.

.3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

.3 Class C fuses.

2.3 **FUSE STORAGE CABINET**

.1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door finished in accordance with Section 26 05 00 - Common Work Results for Electrical.

2.4 **MANUFACTURERS**

.1 Acceptable Products:

.1 Ferraz Shawmut (Mersen)

.2 Cooper Bussman

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install fuses in mounting devices immediately before energizing circuit. Ensure correct fuses fitted to physically matched mounting devices.

.1 Install rejection clips for Class R fuses.

.2 Ensure correct fuses fitted to assigned electrical circuit.

.3 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

.4 Install spare fuses in fuse storage cabinet.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Metering transformer cabinets.

.2 Meter bases.

.3 Prefabricated pad for utility transformer.

1.2 RELATED SECTIONS

.1 Section 26 24 13 - Distribution Switchboards: Metering transformer compartment.

1.3 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

1.4 SYSTEM DESCRIPTION

.1 System Characteristics: 208Y/120 Volts, three-phase, four-wire, 60 Hertz.

.2 Service Entrance: 400A.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Section 01 22 00 - Meetings and Progress Reports: Project management and coordination procedures.

.2 Pre-Installation Meetings:

.1 Convene with utility company representatives at project start, to review work, details and schedules.

.2 Review service entrance requirements and details with utility company's representatives.

1.6 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide ratings and dimensions of transformer cabinets and meter bases.

1.7 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Manufacturer's Drawings: Submit utility company's prepared drawings.

Part 2 - Products

2.1 METERING TRANSFORMER CABINETS

.1 Description: Sheet metal cabinet with hinged door, conforming to utility company requirements, with provisions for locking and sealing.

.2 Size: As required by utility.

2.2 **METER BASES**

.1 Meter Base: Provided by utility company.

2.3 **PREFABRICATED PAD FOR UTILITY TRANSFORMER**

.1 Description: Precast concrete transformer pad with cable pit sized as indicated on drawings.

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verify existing conditions before starting work.

.2 Verify that field measurements are as indicated on utility company's drawings.

3.2 **PREPARATION**

.1 Arrange with utility company to obtain permanent electric service to the project.

.2 Utility shall:

.1 Supply and install padmount transformer

.2 Supply and install primary cable from existing pole at the street to the padmount transformer and terminate cable at each end.

.3 Terminate service entrance feeder to padmount transformer,

.4 Supply revenue metering transformers

.5 Supply, install and connect utility revenue meter.

.6 Connect Owner supplied bulk electrical power meter.

3.3 **INSTALLATION**

.1 Install service rack, weather head, transformer pad, metering transformer cabinets, meter base as required by utility company.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Switchboards.

.2 Power meters.

.3 Metering transformers.

.4 Accessories.

1.2 RELATED SECTIONS

.1 Section 03 30 00 - Cast-in-place Concrete: Concrete for supporting foundations and pads.

.2 Section 26 05 26 - Grounding and Bonding.

.3 Section 26 24 01 - Utility Service Entrance.

1.3 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Building Code (OBC).

.3 ANSI C12.1, Code for Electricity Metering.

.4 CSA-C22.1, Canadian Electrical Code, Part I , Safety Standard for Electrical Installations.

.5 CSA-C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

.6 IEEE C57.13, IEEE Standard Requirements for Instrument Transformers.

.7 NEMA KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

.8 NEMA PB 2, Deadfront Distribution Switchboards.

.9 NEMA PB 2.1, General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 V or Less.

.10 NEMA 260, Safety Labels for Pad Mounted Switchgear and Transformers Sited in Public Areas.

.11 NETA ATS, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.12 CSA C22.2 No. 244 or No. 31 (Switchboard).

.13 UL (Underwriters Laboratories Inc.).

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.

.3 Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral and ground; and switchboard instrument details.

1.5 **SUBMITTALS FOR INFORMATION**

.1 Section 01 33 00 - Submittal Procedures.

.2 Test Reports: Indicate results of factory production tests.

.3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 **CLOSEOUT SUBMITTALS**

.1 Section 01 78 00 - Closeout Submittals.

.2 Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

.3 Record Documentation: Record actual locations of switchboard in project record documents.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Maintenance and extra material requirements.

.2 Extra Stock Materials: Provide two (2) of each key.

1.8 **QUALITY ASSURANCE**

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.9 **REGULATORY REQUIREMENTS**

.1 Products: Listed and classified by CSA and/or ULC as suitable for the purpose specified and indicated.

1.10 **DELIVERY, STORAGE, AND PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Deliver in shipping splits, individually wrapped for protection and mounted on shipping skids.

.3 Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

.4 Handle to manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

Part 2 - Products

2.1 **MANUFACTURERS**

.1 Acceptable Manufacturers:

.1 Eaton Yale Company
.2 Schneider Electric
.3 Siemens Canada
.4 Federal Pioneer

2.2 **SWITCHBOARDS**

.1 Description: switchboard with electrical ratings and configurations as indicated and specified.

.2 Ratings:

.1 Voltage: 120/208 Volts.

.2 Configuration: Three-phase, four-wire, grounded.

.3 Main Bus: Amperes as shown on Drawings.

.4 Integrated Equipment Rating: RMS Amperes symmetrical as shown on Drawings.

.3 Main Section Devices: Individually mounted and compartmented.

.4 Distribution Section Devices: Individually mounted and compartmented.

.5 Auxiliary Section Devices: .

.6 Bus Material: Copper with tin plating, standard size.

.7 Bus Connections: Manufacturer standard, accessible from front for maintenance.

.8 Ground Bus: Extend length of switchboard.

.9 Insulated Ground Bus: Extend length of switchboard.

.10 Moulded Case Circuit Breakers: CSA-C22.2 No. 5, integral thermal and instantaneous magnetic trip in each pole.

.11 Circuit breakers, CSA/ULC listed as Type HACR for air conditioning equipment branch circuits.

.12 Moulded Case Circuit Breakers with Current Limiters: CSA-C22.2 No. 5, moulded case circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole. Include [shunt trip] [undervoltage release] where indicated.

.13 Current Limiting Moulded Case Circuit Breakers: CSA-C22.2 No. 5, moulded case circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 RMS Amperes symmetrical let-through current and energy level less than permitted for same size Class RK-5 fuse. Include [shunt trip] [undervoltage release] where indicated.

.14 Solid-State Moulded Case Circuit Breakers: CSA-C22.2 No. 5, with electronic sensing, timing and tripping circuits for adjustable current settings.

.15 Line and Load Terminations: Accessible from the [front only] [rear] of the switchboard, suitable for the conductor materials and sizes indicated.

.16 Metering Transformer Compartment: For Utility Company's use; compartment size, bus spacing and drilling, door, and locking and sealing requirements to utility company's requirements. Submit Drawings to Utility and obtain approval.

.17 Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

.18 Enclosure: Type 2 - Raintight.

.1 Align sections at [front and rear] [rear only] [front only].

.2 Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

2.3 **ENERGY METERS**

.1 Utility shall provide revenue meters in a separate cabinet for Contractor to install.

.2 Provide Customer digital meters as shown on Drawings

2.4 **METERING TRANSFORMERS**

.1 Obtain metering transformers for revenue meters from Utility and install.

.2 Metering transformers for Customer digital meter shall be manufacturer standard.

2.5 **SOURCE QUALITY CONTROL**

.1 Section 01 45 00 - Quality Control: Manufacturer quality control.

.2 Shop inspect and test switchboard.

.3 Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Owner at least seven (7) days before inspections and tests are scheduled.

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verify existing conditions before starting work.

.2 Verify field measurements on Site prior to shipping.

3.2 **PREPARATION**

.1 Provide concrete housekeeping pad to Section 03 30 00.

3.3 **INSTALLATION**

.1 Install switchboard in locations shown on Drawings, according to CSA-C22.1.

.2 Tighten accessible bus connections and mechanical fasteners after placing switchboard.

.3 Install fuses in each switch.

3.4 **FIELD QUALITY CONTROL**

.1 Section 01 45 00: Field inspection and testing.

.2 Perform inspections and tests listed in NETA ATS.

3.5 **ADJUSTING**

.1 Adjust all operating mechanisms for free mechanical movement.

.2 Tighten bolted bus connections to manufacturer's written instructions.

.3 Adjust circuit breaker trip and time delay settings to values in Coordination Study Report.

3.6 **CLEANING**

.1 Section 01 74 11: Cleaning installed work.

.2 Touch up scratched or marred surfaces to match original finish.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA C22.2 No. 29, Panelboards and Enclosed Panelboards.

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 panelboards and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit manufacturer shop drawings.

.2 Include on drawings:

.1 Electrical detail of panel, branch breaker type, quantity, ampacity, interrupting ratings, bus type, enclosure type and size.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for panelboards for incorporation into manual.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect panelboards from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 **PANELBOARDS**

.1 Panelboards: to CSA C22.2 No. 29 and product of one manufacturer.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 250 and 600 V panelboards: bus and breakers rated for 10 kA (symmetrical) interrupting capacity or as indicated on drawings, whichever is highest.

.3 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 and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Minimum of 2 flush locks for each panel board.

.6 Two keys for each panelboard and key panelboards alike.

.7 Copper bus with neutral of same ampere rating of mains.

.8 Mains: suitable for bolt-on breakers.

.9 Trim with concealed front bolts and hinges.

.10 Trim and door finish: baked enamel.

.11 Isolated ground bus.

.12 Include grounding busbar with 3 of terminals for bonding conductor equal to breaker capacity of the panel board.

2.2 **BREAKERS**

.1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Lock-on devices for 10% of 15 to 30 A breakers or as shown on drawings..

.5 Lock-on devices for fire alarm, emergency, exit circuits.

2.3 **EQUIPMENT IDENTIFICATION**

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Nameplate for each panelboard size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

2.4 **MANUFACTURERS**

.1 Design is based on Eaton Yale Company

.2 Acceptable Products:

.1 Eaton Yale Company

.2 Schneider Electric Company

.3 Siemens Canada

Part 3 - Execution

3.1 **INSTALLATION**

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.

.3 Connect loads to circuits.

.4 Connect neutral conductors to common neutral bus with respective neutral identified.

3.2 **CLEANING**

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.3 **PROTECTION**

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by panelboards installation.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 The electric vehicle supply equipment (EVSE) and all components shall be designed, manufactured and tested in accordance with the latest version of the following standards:

- .1 SAE J1772, J2836, J2847 and J2931
- .2 Ontario Electric Safety Code Section 86
- .3 UL 2231, 2594, 1998
- .4 CSA C22.2 No. 107.1

1.3 SUBMITTALS

.1 Submit the following:

- .1 Cable terminal sizes
- .2 Product data sheets
- .3 Wiring diagrams
- .4 Installation Manuals
- .5 Certified production tender reports
- .6 Installation information including equipment anchorage provisions

1.4 DELIVERY, STORAGE & HANDLING

.1 Electric Vehicle Supply Equipment being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition as required by the manufacturer's instructions in accordance with manufacturer's instructions (1) copy of these instructions shall be included with the equipment at time of shipment.

1.5 OPERATION & MAINTENANCE MANUALS

.1 Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly.

Part 2 - Products

2.1 APPROVED EQUAL MANUFACTURERS

.1 Chargepoint

.2 Ad Energie (Flo Core)

.3 Legrand

.4 General Electric

2.2 CONSTRUCTION

.1 30A, 208V, 1 phase AC, Level 2 pedestal mounted, charging stations, single station and dual station pedestals and truck apparatus charging: Quantities as shown on drawings.

.2 Pedestal and control stations shall be NEMA 3R enclosures.

.3 Provide a UL approved and cUL listed connector that meets SAE J1772 standards. Connector shall be installed on the Electric Vehicle Supply Equipment via a minimum 5.48 m cable.

.4 The station's display shall be simple, with universal symbols to allow easy understanding and use of the Electric Vehicle Supply Equipment.

.5 Provide a cord management system or method to minimize the potential for cable entanglement, user injury or connector damage from lying on the ground and comply with applicable Codes as it applies to cord management systems.

.6 The station shall provide integral overcurrent protection at 5% over the nameplate rating

.7 The station shall be open architecture Standard communications to include Modbus RTU, Modbus TCP and RS-232 Serial for diagnostics.

.8 Stations shall include full provisions for future addition of the following features:

.1 On-board memory storage to record up to 30 days of data and a memory slot to allow for the expansion onto an SD card for up to 2 GB of data.

.2 Wireless communication via Secure Wi-Fi.

2.3 **METERING**

.1 Factory installed integral meter accurate to 1% at nominal voltage.

2.4 **ENERGY MANAGEMENT SYSTEM**

.1 To be provided and installed into EVSE Panel for qty. 22 chargers (future total).

.2 Intellimeter I-meter Electric Vehicle Charging Management Controller EVCMC-24 or equivalent.

Part 3 - Execution

3.1 **FACTORY TESTING**

.1 Each EVSE shall undergo factory testing of all operational and protective features, under full load, prior to shipment.

3.2 **INSTALLATION**

.1 Install all equipment per the manufacturer's recommendations and drawings.

.2 Provide all necessary hardware to secure the assembly in place.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

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, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures. Provide manufacturer's shop drawings.

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 low voltage switchgear from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 SPLITTERS

.1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Terminations: main and branch lugs, connection blocks to match required size and number of incoming and outgoing conductors as indicated.

.3 Spare Terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

2.2 JUNCTION AND PULL BOXES

.1 Construction: welded steel enclosure.

.2 Covers Flush Mounted: 25 mm minimum extension all around.

.3 Covers Surface Mounted: screw-on flat covers.

2.3 **CABINETS**

.1 Construction: welded sheet steel, aluminum or as indicated

Part 3 - Execution

3.1 **SPLITTER INSTALLATION**

.1 Mount plumb, true and square to 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 locations.

.2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.

.3 Install terminal block as indicated in Type T cabinets.

.4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.3 **IDENTIFICATION**

.1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.

.2 Identification Labels: size 2 indicating system name, voltage and phase or as indicated.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA C22.2 No. 42, General Use Receptacles, Attachment Plugs and Similar Devices.

.5 CAN/CSA C22.2 No. 42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).

.6 CSA C22.2 No. 55, Special Use Switches.

.7 CSA C22.2 No. 111, General-Use Snap Switches (Bi-national standard, with UL 20).

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 wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect wiring devices from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 **SWITCHES**

.1 15 or 20 A, 120 V, single pole, double pole, three-way, four-way switches to: CSA C22.2 No. 55 and CSA C22.2 No. 111.

.2 Decora style: All areas except mechanical, electrical and outdoor areas.

.3 Manually-operated general purpose AC switches with following features:

.1 Terminal holes approved for No. 10 AWG wire.

.2 Silver alloy contacts.

.3 Urea or melamine moulding for parts subject to carbon tracking.

.4 Suitable for back and side wiring.

.5 White toggle.

.4 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads and heating loads.

.5 Switches of one manufacturer throughout project.

2.2 **PILOT LIGHTED SWITCHES**

.1 Same as standard switches (Item 2.1) except complete with pilot light. Pilot light to illuminate when lights are ON.

2.3 **TIME SWITCHES**

.1 Digital in-wall timer complete with the following features:

.1 User programmable time range of 1 second up to 24 hours

.2 Non-volatile internal memory (i.e. programming is retained if power fails)

.3 User selectable visual or audible end-of-time warning

.4 Integral push-button style ON/OFF switch

.5 Single pole, 15 Amp, 120 Volt AC

.6 LED compatible

.7 Suitable for use with Decora Style Wall Plate and standard size switch box

.8 White colour

.9 Intermatic EI400 series or approved equal

2.4 **RECEPTACLES**

.1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No. 42 with following features:

.1 Decora style: All areas except Mechanical, Electrical Rooms and outdoor areas.

.2 White urea moulded housing.

.3 Suitable for No. 10 AWG for back and side wiring.

.4 Break-off links for use as split receptacles.

.5 Eight back wired entrances, four side wiring screws.

.6 Triple wipe contacts and rivetted grounding contacts.

.2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:

.1 White urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Four back wired entrances, 2 side wiring screws.

.3 Other receptacles with ampacity and voltage as indicated.

.4 Receptacles fed from Central UPS to be red colour.

.5 Receptacles of one manufacturer throughout project.

2.5 SPECIAL WIRING DEVICES

.1 **Special wiring devices:**

.1 Clock hanger outlets, 15 A, 125 V, 3 wire, grounding type, suitable for No. 10 AWG for installation in flush outlet box.

.2 Electric shaver outlets, 15 A, 125 V, AC with 20 VA isolating transformer with chrome plated cover plate marked RAZOR ONLY.

.3 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic jewel lense flush type.

2.6 WIRING DEVICES FOR COMPUTER ROOMS

.1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No. 42 with following features:

.1 Decora style: All areas except Mechanical, Electrical Rooms and outdoor areas.

.2 Orange urea moulded housing.

.3 Suitable for No. 10 AWG for back and side wiring.

.4 Break-off links for use as split receptacles.

.5 Eight back wired entrances, four side wiring screws.

.6 Triple wipe contacts and rivetted grounding contacts.

.2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:

.1 Orange urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Four back wired entrances, 2 side wiring screws.

.3 Other receptacles with ampacity and voltage as indicated.

.4 Receptacles of one manufacturer throughout project.

2.7 COVER PLATES

.1 Cover plates for wiring devices to: CSA C22.2 No. 42.1.

.2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.3 Stainless steel, vertically brushed, 1 mm thick cover plates mm for wiring devices (convenience outlets and switches) mounted in Utility Rooms, Penthouse and Hangar area.

.4 Plastic white cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.

.5 Sheet metal cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

.7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

2.8 **SOURCE QUALITY CONTROL**

.1 Cover plates from one manufacturer throughout project.

2.9 **MANUFACTURERS**

.1 Acceptable Products:

.1 Legrand Canada
.2 Leviton Canada
.3 Hubbell Canada
.4 Intermatic
.5 Cooper Crouse-Hinds
.6 Cooper Arrowhart

Part 3 - Execution

3.1 **INSTALLATION**

.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.
.3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical as indicated.
.4 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
.5 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results for Electrical as indicated.
.6 Where split receptacle has one portion switched, mount vertically and switch upper portion.
.7 Install GFI type receptacles as indicated.

.2 Cover plates:

.1 Install suitable common cover plates where wiring devices are grouped.
.2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.2 **CLEANING**

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.3 **PROTECTION**

.1 Protect installed products and components from damage during construction.

.2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.3 Repair damage to adjacent materials caused by wiring device installation.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

.2 Section 26 24 13 - Switchboards.

.3 Section 26 24 16.01 - Panelboards Breaker Type.

.4 Section 26 24 16.02 - Panelboards Switch and Fuse Type.

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA-C22.2 No. 5, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include time-current characteristic curves for breakers with ampacity of 100 A and over or with interrupting capacity of 10,000 A symmetrical (RMS) and over at system voltage.

Part 2 - Products

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, Fused circuit breakers, and Accessory high-fault protectors: to CSA C22.2 No. 5

.2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.3 Plug-in moulded case circuit breakers: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.4 Common-trip breakers: with single handle for multi-pole applications.

.5 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.

.6 Circuit breakers with interchangeable trips as indicated.

.7 Circuit breakers to have minimum symmetrical RMS interrupting capacity rating as shown on electrical panel schedules.

2.2 THERMAL MAGNETIC BREAKERS DESIGN A

.1 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.

2.3 **MAGNETIC BREAKERS DESIGN B**

.1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 **CURRENT LIMITING AND SERIES RATED THERMAL MAGNETIC BREAKERS DESIGN C**

.1 Thermal magnetic breakers with current limiters.

.1 Time current limiting characteristics of fuses limiters coordinated with time current tripping characteristics of circuit breaker.

.2 Co-ordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker.

.2 Series rated breakers to be manufacturer tested and listed. Breakers to be applied following manufacturer's guidelines and accepted best practice.

.1 Breakers applied following manufacturer's guidelines and accepted best practice.

2.5 **SOLID STATE TRIP BREAKERS DESIGN D**

.1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time short time instantaneous tripping for phase ground fault short circuit protection.

2.6 **OPTIONAL FEATURES**

.1 Include:

.1 Shunt trip.
.2 Auxiliary switch.
.3 Motor-operated mechanism complete with time delay unit.
.4 Under-voltage release.
.5 On-off locking device.
.6 Handle mechanism.

2.7 **ENCLOSURE**

.1 Refer to electrical panel schedules.

2.8 **MANUFACTURERS**

.1 Acceptable Products:

.1 Eaton Yale Company
.2 Schneider Electric Company
.3 Siemens Canada

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install circuit breakers as indicated.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

.2 Section 26 05 83 - Wiring Connections.

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA C22.2 No. 14, Industrial Control Equipment.

.5 NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.

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 contactors and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for contactors for incorporation into manual.

.3 Include operating information required for start-up, synchronizing and shut-down of generating units.

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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect contactors from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 CONTACTORS

.1 Contactors: to CSA C22.2 No. 14.

.2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.

.3 Breaker or fused switch combination contactor as indicated.

.4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.5 Mount in CSA NEMA Enclosure as shown on drawings.

.6 Include following options in cover (if shown on drawings):

.1 Red, Green indicating lamp.

.2 Stop-Start pushbutton.

.3 Hand-Off-Auto selector switch.

.4 On-Off selector switch.

.7 Control transformer: in accordance with Section 26 05 83 - Wiring Connections, factory wired and installed in contactor enclosure.

2.2 **EQUIPMENT IDENTIFICATION**

.1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Size 4 nameplate indicating name of load controlled as indicated.

2.3 **MANUFACTURERS**

.1 Acceptable Products:

.1 Eaton Yale Company.

.2 Schneider Electric Company

.3 Siemens Canada

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install contactors and connect power wires and auxiliary control devices.

.2 Identify contactors with nameplates or labels indicating panel and circuit number.

.3 Test contactors in accordance with 26 05 00 - Common Work Results for Electrical.

3.2 **CLEANING**

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.3 **PROTECTION**

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by contactor installation.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical

.2 Section 26 24 13 - Switchboards

.3 Section 26 24 16.01 - Panelboards Breaker Type

.1 Section 26 24 16.02 - Panelboards Switch and Fuse Type

.2 Section 26 28 16.01 - Air Circuit Breakers

.3 Section 26 28 16.02 - Moulded Case Circuit Breakers

1.2 PAYMENT

.1 Payment for field testing of ground fault equipment performed by Contractor, independent testing laboratory or equipment manufacturer is the responsibility of the Contractor.

1.3 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CAN/CSA C22.2 No. 144, Ground Fault Circuit Interrupters.

.5 NEMA PG 2.2, Application Guide for Ground Fault Protection Devices for Equipment.

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 ground fault equipment protection and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit manufacturer's drawings

.4 Test and Evaluation Reports: submit test report for field testing of ground fault equipment to Consultant and certificate that system as installed meets criteria specified.

1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for ground fault equipment protection for incorporation into manual.

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 ground fault equipment protection from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 **EQUIPMENT**

.1 Ground fault protective equipment: components of one manufacturer.

.2 Provide ground fault protection on solidly grounded (wye) services 1000A and larger : to NEMA PG 2.2 and CAN/CSA C22.2 No. 144.

.3 Ground fault unit to contain:

.1 Ground sensing relay suitable for operation at maximum 1200A. Control voltage: 600V and maximum time delay shall be 1 second for ground fault currents equal to or greater than 3000 A.

.2 Ammeter with scale 0 to 3000 A to indicate ground current value.

.3 Three position sensitivity control switch to select value of leakage current at which relay will operate.

.4 Indicating lamp illuminated when no ground fault exists, extinguished on ground fault or test.

.5 Switch:

.1 SPDT contacts for alarm and trip.

.2 Mechanical target indication.

.3 Manual reset.

.6 Reset button for contacts and target.

.7 Suitable for panel mounting.

.4 Zero sequence transformer type with 300 - 3000 mA range.

.5 Neutral:

.1 Use an artificial neutral and grounding resistor.

.2 Use neutral ground resistor unit.

.6 System to operate on maximum time delay of 1s at ground current setting.

2.2 **FABRICATION**

.1 Install following components in equipment specified in other Sections and as indicated.

.1 Zero sequence transformer.

.2 Ground fault relay.

.3 Ground resistor unit.

2.3 **RELATED EQUIPMENT**

.1 Shunt trip breakers. Load break disconnect switch.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Do not ground neutral on load side of sensor.

.2 Install phase conductors including neutral through zero sequence transformer.

.3 Install ground fault protection system.

.4 Make connections as indicated and in accordance with manufacturer's written recommendations.

3.2 **FIELD QUALITY CONTROL**

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and co-ordinate with Section 01 45 00 - Quality Control, if required.

.2 Arrange for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.

.3 Demonstrate simulated ground fault tests.

3.3 **CLEANING**

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

1.2 PAYMENT

.1 Payment for field testing of ground fault equipment performed by Contractor or equipment manufacturer is the responsibility of the Contractor.

1.3 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CAN/CSA C22.2 No. 144, Ground Fault Circuit Interrupters.

.5 NEMA PG 2.2, Application Guide for Ground Fault Protection Devices for Equipment.

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 ground fault circuit interrupters and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit manufacturer's drawings.

.4 Test and Evaluation Reports: submit test report for field testing of ground fault equipment to Consultant and certificate that system as installed meets criteria specified.

1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for ground fault circuit interrupters for incorporation into manual.

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 ground fault circuit interrupters from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 **MATERIALS**

.1 Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA C22.2 No. 144 NEMA PG 2.2.

.2 Components comprising ground fault protective system to be of same manufacturer.

2.2 **BREAKER TYPE GROUND FAULT INTERRUPTER**

.1 Single or Two pole ground fault circuit interrupter for 15A, 120V or 208V, 1 phase circuit complete with test and reset facilities.

2.3 **GROUND FAULT LIFE PROTECTOR**

.1 2-pole circuit breaker to supply power to mains of a single-phase panel and complete with:

.1 Automatic shunt trip breaker.

.2 Zero sequence current sensor.

.3 Facilities for testing and reset.

.4 CSA Enclosure, as shown in Panel Schedules.

.5 Ground fault trip indicator light.

2.4 **GROUND FAULT PROTECTOR UNIT**

.1 Self-contained with 15A, 120V circuit interrupter and duplex receptacle complete with:

.1 Solid state ground sensing device.

.2 Facility for testing and reset.

.3 CSA Enclosure 1, surface or flush mounted with stainless steel painted face plate.

2.5 **MANUFACTURERS**

.1 Acceptable Products:

.1 Eaton Cutler Hammer Canada

.2 Schneider Electric Canada

.3 Siemens Canada

.4 General Electric Canada

Part 3 - Execution

3.1 **INSTALLATION**

.1 Do not ground neutral on load side of ground fault relay. Pass phase conductors including neutral through zero sequence transformers.

.2 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.2 **FIELD QUALITY CONTROL**

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and co-ordinate with Section 01 45 00 - Quality Control, if required.

.2 Arrange for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.

.3 Demonstrate simulated ground fault tests.

3.3 **CLEANING**

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 - General

1.1 **RELATED REQUIREMENTS**

.1 Section 26 05 00 - Common Work Results for Electrical.

.2 Section 26 18 16 - Fuses - Low Voltage.

1.2 **REFERENCES**

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CAN/CSA C22.2 No. 4, Enclosed Switches.

.5 CSA C22.2 No. 39, Fuseholder Assemblies.

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

1.4 **HEALTH AND SAFETY**

.1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

Part 2 - Products

2.1 **DISCONNECT SWITCHES**

.1 Fusible, non-fusible, horsepower rated disconnect switches in CSA Enclosures, to CAN/CSA C22.2 No. 4, size as indicated.

.2 Provision for padlocking in Off switch position by three locks.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Fuses: size as indicated, in accordance with Section 26 18 16 - Fuses - Low Voltage.

.5 Fuseholders: to CSA C22.2 No. 39 relocatable and suitable without adaptors, for type and size of fuse indicated.

.6 Quick-make, quick-break action.

.7 ON-OFF switch position indication on switch enclosure cover.

2.2 **EQUIPMENT IDENTIFICATION**

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Indicate name of load controlled on size 4 nameplate.

2.3 **MANUFACTURERS**

.1 Acceptable Products:

.1 Eaton Yale Company

.2 Schneider Electric Company

.3 Siemens Canada

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical..

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 NEMA/EEMAC Rated Starters, CSA C22.2, No. 14, EEMAC 14-1

.5 IEC 947-4-1, Part 4: Electromechanical contactors and motor-starters.

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, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Provide shop drawings for each type of starter to indicate:

.1 Mounting method and dimensions.

.2 Starter size and type.

.3 Layout and components.

.4 Enclosure types.

.5 Wiring diagram.

.6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

.1 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.

.2 Extra Materials:

.1 Provide listed spare parts for each different size and type of starter.

.1 Three (3) sets contacts, stationary.

.2 Three (3) sets contacts, movable.

.3 One (1) set contacts, auxiliary.

.4 One (1) control transformer.

.5 One (1) operating coil.

.6 Two (2) fuses.

.7 10% indicating lamp bulbs used.

1.5 **DELIVERY, STORAGE AND HANDLING**

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

Part 2 - Products

2.1 **MATERIALS**

.1 Starters: to IEC 947-4 with AC4 utilization category.

2.2 **MANUAL MOTOR STARTERS**

.1 Single or Three 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 (1) or Three (3) overload heaters, manual reset, trip indicating handle.

.2 Accessories:

.1 Toggle Key switch or pushbutton: heavy duty, oil tight labelled as indicated.

.2 Indicating light: heavy duty, oil tight type and colour as indicated.

.3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 **FULL VOLTAGE MAGNETIC STARTERS**

.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated, rapid action type.

.2 Motor overload protective device in each phase, manually reset from outside enclosure.

.3 Wiring and schematic diagram inside starter enclosure in visible location.

.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include fused disconnect switch, motor circuit interrupter or circuit breaker with operating lever on outside of enclosure to control disconnect, motor circuit interrupter, or circuit breaker, and provision for:

.1 Locking in "OFF" position with up to 3 padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to "ON" position while enclosure door open.

.3 Accessories:

.1 Pushbuttons Selector switches: heavy duty, oil tight labelled as indicated.

.2 Indicating lights: heavy duty, oil tight type and color as indicated.

.3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.4 **FULL VOLTAGE REVERSING MAGNETIC STARTERS**

.1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Two (2) 3-pole magnetic contactors mounted on common base.

.2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.

.3 Three (3) overload relays with heater elements, manual or automatic reset.

.2 Accessories:

.1 Pushbuttons or Selector switches: heavy duty, oil tight labelled as indicated.

.2 Indicating lights: heavy duty, oil tight type and color as indicated.

.3 Auxiliary control devices as indicated.

2.5 MULTI-SPEED STARTERS

.1 2-speed starters of size, type, rating and enclosure type as indicated. Starter suitable for constant torque or variable torque or constant kW type motor and with components as follows:

.1 One (1) 3-pole contactor for each winding for separate winding motors.

.2 One (1) 3-pole and one (1) 5-pole contactor for each re-connectable winding for consequent pole type motors.

.3 Three (3) overload relays with three (30 heater elements and manual reset for each speed.

.2 Accessories:

.1 Pushbuttons Selector switches: heavy duty, oil tight labelled as indicated.

.2 Indicating lights: heavy duty, oil tight, type and color as indicated.

.3 Auxiliary control devices as indicated.

.4 Low speed compelling relay or automatic sequence, accelerating or decelerating relays for each speed.

2.6 MAGNETIC STARTER, REDUCED VOLTAGE, AUTO-TRANSFORMER

.1 Auto-transformer starter closed circuit transition type, of size, type, rating and enclosure type as indicated and with following components:

.1 Three (3) 3-pole contactors.

.2 Auto-transformer with 50%, 65% and 80% taps.

.3 One (1) adjustable pneumatic timing relay.

.4 One (1) 3-pole manual reset overload device.

.5 Thermal overload protection of auto-transformers.

.2 Accessories:

.1 Pushbuttons or Selector switches: heavy duty, oil tight labelled as indicated.

.2 Indicating lights: heavy duty, oil tight type and color as indicated.

.3 Auxiliary control devices as indicated.

2.7 MAGNETIC STARTER REDUCED VOLTAGE STAR-DELTA

.1 Reduced voltage star-delta open transition starter, of size, type, rating and enclosure type as indicated, with components as follows:

.1 Two (2) 3-pole delta contactors with auxiliary relays and interlocks.

.2 One (1) 3-pole star contactor with auxiliary relays and interlocks.

.3 Mechanical interlock to interlock one delta contactor and the star contactor.

.4 One timing relay.

.5 Three pole manual or automatic reset overload relays.

.2 Reduced voltage star-delta closed transition starter, of size, type, rating and enclosure type as indicated, with components as follows:

.1 Two (2) 3-pole delta contactors with auxiliary relays and interlocks.
.2 One (1) 3-pole star contactor with auxiliary relay and interlocks.
.3 One (1) 3-pole transition contactor.
.4 One (1) set of transition resistors.
.5 Mechanical interlock, to interlock one delta contactor and the star contactor.
.6 One timing relay.
.7 Three pole manual or automatic reset overload relays.

.3 Accessories:

.1 Pushbuttons or Selector switches: heavy duty, oil tight labelled as indicated.
.2 Indicating lights: heavy duty, oil tight, type and color as indicated.
.3 Auxiliary control devices as indicated.

2.8 MAGNETIC STARTER REDUCED VOLTAGE PART WINDING

.1 Two-step reduced voltage, part winding starter of size, type, rating and enclosure type as indicated, with components as follows:

.1 Two (2) 3-pole contactors.
.2 Adjustable pneumatic timer.
.3 Six (6) manual or automatic reset overload relays.

.2 Three-step reduced voltage part winding starter of size, type, rating and enclosure type as indicated, with components as follows:

.1 Three (3) 3-pole contactors.
.2 One (1) set starting resistors.
.3 Six (6) manual or automatic reset overload relays.

.3 Accessories:

.1 Pushbuttons or Selector switches: heavy duty, oil tight labelled as indicated.
.2 Indicating lights: heavy duty, oil tight type and color as indicated.
.3 Auxiliary control devices as indicated.

2.9 THREE PHASE MANUAL REVERSING STARTER

.1 Three phase manual reversing starter of size, type, rating and enclosure type as indicated, with components as follows:

.1 Two (2) 3-pole manual motor starters, quick make and break.
.2 Six (6) overload relays and manual reset.
.3 Mechanical interlock to prevent both switches from closing at same time.

.2 Accessories:

.1 Pushbuttons or Selector switches: heavy duty oil tight labelled as indicated.
.2 Indicating lights: heavy duty oil tight type and colour as indicated.

2.10 **THREE PHASE MANUAL TWO-SPEED SEPARATE WINDING STARTERS**

.1 Three phase manual two-speed separate winding starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Two (2) 3-pole manual motor starters, quick make and break.

.2 Six (6) overload relays and manual reset.

.3 Mechanical interlock to prevent both switches from closing at same time.

.2 Accessories:

.1 Pushbuttons or Selector switches: heavy duty oil tight labelled as indicated.

.2 Indicating lights: heavy duty oil tight type and colour as indicated.

2.11 **DC FULL VOLTAGE NON-REVERSING STARTERS**

.1 DC full voltage non-reversing starters of size, type, rating and enclosure type as indicated, with components as follows:

.1 Contactor: single or two-pole solenoid operated type.

.2 Indirectly-heated, manual reset thermal overload relay.

.2 Accessories:

.1 Pushbuttons: heavy duty, oil tight labelled as indicated.

.2 Selector switches: heavy duty, oil tight labelled as indicated.

.3 Indicating lights: heavy duty, oil tight type and colour as indicated.

2.12 **DC FULL VOLTAGE REVERSING STARTERS**

.1 DC full voltage reversing starter of size, type, rating and enclosure type as indicated, with components as follows:

.1 Two (2) contactors: single or two pole solenoid operated type, mechanically and electrically interlocked.

.2 Indirectly-heated, manual reset thermal overload relay.

.2 Accessories:

.1 Pushbutton or Selector switches: heavy duty labelled as indicated.

.2 Indicating lights: heavy duty, oil tight, type and colour as indicated.

.3 Auxiliary control devices as indicated.

2.13 **SOLID-STATE REDUCED-VOLTAGE MOTOR CONTROL**

.1 Reduced Voltage Motor Starter Type S811

.1 Controller shall be Eaton type S811

.2 The solid-state reduced-voltage starter shall be UL and CSA listed. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing

.3 The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV

.4 Units using triacs or SCR/diode combinations shall not be acceptable

.5 Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dV/dT effects

.6 The logic board shall be mounted for ease of testing, service and replacement. It shall have quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits

.7 The logic board shall be identical for all ampere ratings and voltage classes and shall be conformally coated to protect environmental concerns

.8 The paralleling run bypass contactor shall energize when the motor reaches 90 of full speed and close/open under one (1) times motor current

.9 The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions

.10 Digital interface module mounted on the face of the S811 shall be used to program the soft starter. Display shall include six line LED readout. Monitoring parameters shall include line currents, pole currents, pole voltages, number of starts, and DC control voltage. Soft starter shall display motor status and the previous 5 fault conditions

.11 Starter shall be provided with electronic overload protection as standard and shall be based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via digital interface module

.12 Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter

.13 Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad

.14 Starter shall be capable of either an electronic or mechanical reset after a fault

.15 Units using bimetal overload relays are not acceptable

.16 Overtemperature protection (on heat sink) shall be standard

.17 Starters shall provide protection against improper line-side phase rotation as standard. Starter will shut down if a line-side phase rotation other than A-B-C exists. This feature can be disabled via digital interface module

.18 Starters shall provide protection against a phase loss or unbalance condition as standard. Starter will shut down if a 50% current differential between any two phases is encountered. This feature can be disabled via digital interface module

.19 Start shall provide protection against a motor stall condition as standard. This feature can be disabled via digital interface module.

.20 Starter shall provide protection against a motor jam condition as standard. This feature can be disabled via digital interface module

.21 Starter shall be provided with a Form C normally open (NO), normally closed (NC) contact that shall change state when a fault condition exists. Contacts shall be rated 60 VA (resistive load) and 20 VA (inductive load). In addition, an LED display on the device keypad shall indicate type of fault (Overtemperature, Phase Loss, Jam, Stall, Phase Reversal and Overload)

.22 The following control function adjustments from digital interface module are required:

- .1 Selectable Torque Ramp Start or Current Limit Start
- .2 Adjustable Kick Start Time: 0 - 2 seconds
- .3 Adjustable Kick Start Torque: 0 - 85%
- .4 Adjustable Ramp Start Time: 0.5 - 180 seconds
- .5 Adjustable Initial Starting Ramp Torque: 0 - 85%
- .6 Adjustable Smooth Stop Ramp Time: 0 - 60 seconds.

.23 Units enclosed in motor control centers shall be of the same manufacturer as that of the circuit breaker and motor control center for coordination and design issues

.24 Maximum continuous operation shall be at 115% of continuous ampere rating

.25 Pump Control Option - Provide control algorithm for pump start-up and shut down sequences. Control algorithm shall reduce the potential for water hammer in a centrifugal pump system. Upon a start command, the speed of the motor is increased, under the control of the IT. Soft Starter microprocessor, to achieve a gentle start. After the speed has reached its nominal value, the bypass contactors close and the pump. Upon a stop command, the bypass contactors are opened and the motor speed is decreased in a tapered manner, to gradually slow the flow until the motor is brought to a stop. The start and stop ramp times are user adjustable and are to be set for the application requirements. The pump control option shall be factory installed.

.26 600V 120V Power supply as required

.2 Reduced Voltage Motor Starter Type S801

.1 Controller shall be Eaton type S801

.2 The solid-state reduced-voltage starter shall be UL and CSA listed. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing

.3 The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV

.4 Units using triacs or SCR/diode combinations shall not be acceptable

.5 Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dV/dT effects

.6 The logic board shall be mounted for ease of testing, service and replacement. It shall have quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits

.7 The logic board shall be identical for all ampere ratings and voltage classes and shall be conformally coated to protect environmental concerns

.8 The paralleling run bypass contactor shall energize when the motor reaches 90 of full speed and close/open under one (1) times motor current

.9 The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions

.10 Starter shall be provided with electronic overload protection as standard and shall be based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via a DIP switch setting on the device keypad

.11 Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter

.12 Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad

.13 Starter shall be capable of either an electronic or mechanical reset after a fault

.14 Units using bimetal overload relays are not acceptable

.15 Overtemperature protection (on heat sink) shall be standard

.16 Starters shall provide protection against improper line-side phase rotation as standard. Starter will shut down if a line-side phase rotation other than A-B-C exists. This feature can be disabled via a DIP switch on the device keypad

.17 Starters shall provide protection against a phase loss or unbalance condition as standard. Starter will shut down if a 50% current differential between any two phases is encountered. This feature can be disabled via a DIP switch on the device keypad

.18 Start shall provide protection against a motor stall condition as standard. This feature can be disabled via a DIP switch on the device keypad

.19 Starter shall provide protection against a motor jam condition as standard. This feature can be disabled via a DIP switch on the device keypad

.20 Starter shall be provided with a Form C normally open (NO), normally closed (NC) contact that shall change state when a fault condition exists. Contacts shall be rated 60 VA (resistive load) and 20 VA (inductive load). In addition, an LED display on the device keypad shall indicate type of fault (Overtemperature, Phase Loss, Jam, Stall, Phase Reversal and Overload)

.21 The following control function adjustments on the device keypad are required:

.1 Selectable Torque Ramp Start or Current Limit Start

.2 Adjustable Kick Start Time: 0 - 2 seconds

.3 Adjustable Kick Start Torque: 0 - 85%

.4 Adjustable Ramp Start Time: 0.5 - 180 seconds

.5 Adjustable Initial Starting Ramp Torque: 0 - 85%

.6 Adjustable Smooth Stop Ramp Time: 0 - 60 seconds.

.22 Units enclosed in motor control centers shall be of the same manufacturer as that of the circuit breaker and motor control center for coordination and design issues

.23 Maximum continuous operation shall be at 115% of continuous ampere rating

.24 Pump Control Option - Provide control algorithm for pump start-up and shut down sequences. Control algorithm shall reduce the potential for water hammer in a centrifugal pump system. Upon a start command, the speed of the motor is increased, under the control of the IT. Soft Starter microprocessor, to achieve a gentle start. After the speed has reached its nominal value, the bypass contactors close and the pump. Upon a stop command, the bypass contactors are opened and the motor speed is decreased in a tapered manner, to gradually slow the flow until the motor is brought to a stop. The start and stop ramp times are user adjustable and are to be set for the application requirements. The pump control option shall be factory installed.

.25 600V, or 120V power supply as required

2.14 CONTROL TRANSFORMER

.1 Single phase, dry type, control transformer with primary voltage as indicated and 120V secondary, complete with secondary fuse, installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.15 ACCESSORIES

.1 Pushbutton: heavy duty, oil tight as required.

.2 Selector switches: heavy duty, oil tight as required.

.3 Indicating lights: heavy duty, oil tight, type and colour as indicated.

2.16 FINISHES

.1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

2.17 **EQUIPMENT IDENTIFICATION**

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

.3 Magnetic starter designation label, white plate, black letters, size 6 mm engraved as indicated.

2.18 **MANUFACTURERS**

.1 Acceptable products:

.1 Eaton Cutler Hammer Canada
.2 Schneider Electric Canada
.3 Siemens Canada
.4 General Electric Canada

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install starters and control devices in accordance with manufacturer's instructions.

.2 Install and wire starters and controls as indicated.

.3 Ensure correct fuses installed.

.4 Confirm motor nameplate and adjust overload device to suit.

3.2 **FIELD QUALITY CONTROL**

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.

.2 Operate switches and 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.

3.3 **CLEANING**

.1 Clean in accordance with Section 01 74 11 - Cleaning and Section 01 75 19 - Construction & Demolition Waste Management.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Manual motor controllers.

.2 Magnetic motor controllers.

.3 Combination magnetic motor controllers.

1.2 RELATED SECTIONS

.1 Section 26 05 00 - Common Work Results for Electrical

.2 Section 26 05 29 - Hangers & Supports for Electrical Systems.

1.3 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA-C22.2 No. 14, Industrial Control Equipment.

.5 CSA-C22.2 No. 248.1, Low-voltage fuses - Part 1: General requirements.

.6 CSA-C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

.7 CAN/CSA-C22.2 No. 94, Special Purpose Enclosures.

.8 CSA-C22.2 No. 4, Enclosed and Dead-Front Switches.

.9 CSA (Canadian Standards Association).

.10 UL (Underwriters Laboratories Inc.).

1.4 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide catalogue sheets showing voltage, controller size, ratings and size of switching and over-current protective devices, short circuit ratings, dimensions, and enclosure details.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Test Reports: Indicate field test and inspection procedures and test results.

.3 Installation Data: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Stock Materials: Provide three (3) of each size and type fuse installed.

1.7 **QUALITY ASSURANCE**

.1 Products of this Section: Manufactured to ISO 9000 certification requirements.

.2 Perform Work to CSA-C22.1.

.3 Maintain one (1) copy of each document on site.

.4 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.8 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by CSA/UL as suitable for purpose specified and indicated.

Part 2 - Products

2.1 **MANUFACTURERS**

.1 Eaton Yale Company

.2 Schneider Electric

.3 Substitutions: Not permitted.

2.2 **MANUAL CONTROLLERS**

.1 Manual Motor Controller: CSA-C22.2 No. 14, AC general-purpose and Industrial grade, as applicable, Class A, manually operated, full-voltage controller with overload element, red pilot light, NO, NC, auxiliary contact and push button operator.

.2 Fractional Horsepower Manual Controller: CSA-C22.2 No. 14, AC general-purpose and Industrial grade, as applicable, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red green pilot light, and key toggle operator.

.3 Motor Starting Switch: CSA-C22.2 No. 14, AC general-purpose and Industrial grade, as applicable, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with red, green pilot light and toggle operator.

.4 For additional features such as Hand-Off-Auto switches, see wiring schedules.

.5 Enclosure: See drawings

2.3 **AUTOMATIC CONTROLLERS**

.1 Magnetic Motor Controller: CSA-C22.2 No. 14, AC general-purpose and Industrial grade, as applicable, Class A, magnetic controller for induction motors rated in horsepower.

.2 Reversing Controllers: Include electrical interlock and integral time delay transition between FORWARD and REVERSE rotation.

.3 For additional features such as Hand-Off-Auto switches, see wiring schedules.

.4 Two-Speed Controllers: Include integral time delay transition between FAST and SLOW speeds.

.5 Coil operating voltage: See drawings

.6 Overload Relay: CSA-C22.2 No. 14; bimetal.

.7 Enclosure: See drawings

2.4 **PRODUCT OPTIONS AND FEATURES**

.1 Auxiliary Contacts: CSA-C22.2 No. 14, two (2) each normally open and normally closed contacts in addition to seal-in contact.

.2 Cover Mounted Pilot Devices: CSA-C22.2 No. 14.

.3 Pilot Device Contacts: CSA-C22.2 No. 14, Form Z, rated A150.

.4 Pushbuttons: Unguarded type.

.5 Indicating Lights: LED type.

.6 Selector Switches: Rotary type.

.7 Relays: CSA-C22.2 No. 14.

.8 Control Power Transformers: 120 volt secondary unless indicated otherwise.

2.5 **DISCONNECTS**

.1 Combination Controllers: Combine motor controllers with thermal magnetic circuit breaker, motor circuit protector, non-fusible switch or fusible switch disconnect, as applicable, in common enclosure.

.2 Thermal Magnetic Circuit Breakers: CAN/CSA-C22.2 No. 5, with integral thermal and instantaneous magnetic trip in each pole.

.3 Motor Circuit Protector: CAN/CSA-C22.2 No. 5, circuit breakers with integral instantaneous magnetic trip in each pole.

.4 Non-fusible Switch Assemblies: CAN/CSA-C22.2 No. 4, enclosed knife switch with externally operable handle.

.5 Fusible Switch Assemblies: CAN/CSA-C22.2 No. 4, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R J fuses.

2.6 **FUSES**

.1 Manufacturers:

.1 Eaton Yale Company

.2 Schneider Electric Company

.3 Siemens Canada

.4 Substitutions: Not permitted.

.2 Description: Dual element current limiting, time delay one-time fuse, 250 or 600 volt as applicable.

.3 Interrupting Rating: 200,000 RMS amperes.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install enclosed controllers where indicated, to manufacturer's written instructions.

.2 Install enclosed controllers plumb. Provide supports to Section 26 05 29.

.3 Height: 5 ft. to operating handle.

.4 Install fuses in fusible switches.

.5 Select and install overload thermal elements in motor controllers to match installed motor characteristics.

.6 Provide engraved plastic nameplates under the provisions of Section 26 05 00.

.7 Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.2 **FIELD QUALITY CONTROL**

.1 Section 01 45 00 - Quality Control: Field inspection testing.

.2 Inspect and test each enclosed controller to CSA-C22.2 No. 14.

END OF SECTION

Part 1 - General

1.1 SECTION INCLUDES

.1 Variable frequency controller.

1.2 RELATED SECTIONS

.1 Section 03 30 00 - Cast-in-place Concrete: Housekeeping pads.

.2 Section 26 05 00 - Common Work Results for Electrical: Engraved nameplates.

1.3 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA-C22.2 No. 14 - Industrial Control Equipment.

.5 NEMA ICS 3.1 - Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers.

.6 NEMA 250 - Enclosures for Electrical Equipment (1000 Volt Maximum).

.7 CSA (Canadian Standards Association).

.8 UL (Underwriters Laboratories Inc.).

1.4 SYSTEM DESCRIPTION

.1 Provide enclosed variable frequency controllers suitable for operating the indicated loads. Conform to requirements of CSA-C22.2 No. 14, NEMA ICS 3.1.

1.5 SUBMITTALS FOR REVIEW

.1 Section 01 33 00 - Submittal Procedures.

.2 Product Data: Provide catalogue sheets showing voltage, controller size, ratings and size of switching and over-current protective devices, short circuit ratings, dimensions, and enclosure details.

.3 Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

1.6 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00 - Submittal Procedures.

.2 Test Reports: Indicate field test and inspection procedures and test results.

.3 Installation Data: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

.4 Manufacturer's Field Reports: Indicate start-up inspection findings.

1.7 **CLOSEOUT SUBMITTALS**

.1 Section 01 78 00 - Closeout Submittals.

.2 Maintenance Contracts: Provide service and maintenance of controller for one (1) year from Date of Substantial Completion.

.3 Maintenance Data: Include routine preventive maintenance schedule.

.4 Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

1.8 **MAINTENANCE MATERIAL SUBMITTALS**

.1 Extra Stock Materials:

.1 Provide two (2) of each air filter.

.2 Provide three (3) of each fuse size and type.

1.9 **QUALITY ASSURANCE**

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.10 **REGULATORY REQUIREMENTS**

.1 Provide products listed and classified by CSA, UL as suitable for purpose specified and indicated.

1.11 **DELIVERY, STORAGE, AND PROTECTION**

.1 Transport, handle, store, and protect products.

.2 Accept controllers on site in original packing. Inspect for damage.

.3 Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

.4 Handle to manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

Part 2 - Products

2.1 **MANUFACTURERS**

.1 Manufacturers:

.1 Eaton Yale Company

.2 Schneider Electric

.3 ABB Canada

2.2 **RATINGS**

.1 Rated Input Voltage: 208/240/600 Volts as indicated, three phase, 60 Hertz.

.2 Motor Nameplate Voltage: 200/230/460 Volts as indicated, three phase, 60 Hertz.

.3 Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.

.4 Operating Ambient: 0 to 40 degrees C (32 to 104 degrees F).

.5 Minimum Efficiency at Full Load: 95%.

2.3 **DESIGN**

.1 Employ microprocessor based inverter logic isolated from power circuits.

.2 Employ pulse width modulated inverter system.

.3 Employ switching power supply operating off DC link.

.4 Design for ability to operate controller with motor disconnected from output.

.5 Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.

2.4 **PRODUCT OPTIONS AND FEATURES**

.1 Display: Provide integral digital display to indicate output voltage, output frequency, and output current.

.2 Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.

.3 Volts Per Hertz Adjustment: Plus or minus 10%.

.4 Current Limit Adjustment: 60 - 110% of rated.

.5 Acceleration Rate Adjustment: 0.5 - 30 seconds.

.6 Deceleration Rate Adjustment: 1 - 30 seconds.

.7 Provide HAND-OFF-AUTOMATIC selector switch and manual speed control.

.8 Input Signal:

.1 0-10 mV DC.

.2 4-20 mA DC

.3 Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.

.9 Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.

.10 Manual Bypass: Provide contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.

.11 Disconnecting Means: Include integral fused disconnect switch or circuit breaker on the line side of each controller.

2.5 **FABRICATION**

.1 Wiring Terminations: Match conductor materials and sizes indicated.

.2 Enclosure: EEMAC, Type 1.

.3 Finish: Manufacturer's standard enamel.

2.6 **SOURCE QUALITY CONTROL**

.1 Section 01 45 00 - Quality Control: Manufacturer quality control.

.2 Inspect and production-test each product specified in this section.

Part 3 - Execution

3.1 **EXAMINATION**

.1 Verify existing conditions before starting work.

.2 Verify that field measurements are as indicated on Shop Drawings.

.3 Verify that surface is suitable for controller installation.

.4 Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.2 **PREPARATION**

.1 Provide concrete housekeeping pad under the provisions of Section 03 30 00.

3.3 **INSTALLATION**

.1 Install controller where indicated, to manufacturer's written instructions.

.2 Tighten accessible connections and mechanical fasteners after placing controller.

.3 Install fuses in fusible switches.

.4 Select and install overload heater elements in motor controllers to match installed motor characteristics.

.5 Provide engraved plastic nameplates under the provisions of Section 26 05 00.

.6 Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load Amperes, code letter, service factor, and voltage/phase rating.

3.4 **FIELD QUALITY CONTROL**

.1 Section 01 45 00 - Quality Control: Field inspection & testing.

.2 Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

3.5 **MANUFACTURER'S FIELD SERVICES**

.1 Prepare and start components.

.2 Monitor and report unacceptable conditions.

3.6 **ADJUSTING**

.1 Make final adjustments to installed drive to assure proper operation of fan system. Obtain performance requirements from installer of driven loads.

3.7 **CLEANING**

.1 Section 01 74 11 - Cleaning: Cleaning installed work.

.2 Touch up scratched or marred surfaces to match original finish.

3.8 **CLOSEOUT ACTIVITIES**

.1 Demonstration: Demonstrate operation of controllers in automatic and manual modes.

END OF SECTION

Part 1 - General

1.1 SUBMITTALS

.1 Submit shop drawings for products specified in this Section, including but not be limited to following:

- .1 engine generator set (genset) with accessories;
- .2 genset control panel and related controls;
- .3 integration drawings identifying various integration points of other systems of building.

.2 Include following with shop drawings:

- .1 full design detail drawings and layouts;
- .2 wiring schematics;
- .3 dimensions of set and associated major components;
- .4 electrical characteristics;
- .5 power data;
- .6 fuel consumption data;
- .7 a point by point description of control system software sequence of operation.

1.2 TYPICAL DETAILS

.1 Refer to typical details found on drawings for references to products and/or execution required in this Section.

1.3 WARRANTY

.1 Warrant (full 100% parts and labour with no deductible amounts) gensets, and control system equipment in writing, to be in strict accordance with Specification and free from defects for 1 year from date of turn over to Owner. Warranty period starts after acceptance tests and subsequent written acceptance by Consultant and after full connection to building load.

.2 Include for 24 hours around clock service by manufacturer/supplier.

.3 Include with warranty, following:

- .1 first year routine maintenance service including parts and labour;
- .2 at least one complete oil and filter change;
- .3 Manufacturer recommended maintenance and servicing to maintain validity of warranty.

.4 Include special warranty provision that during warranty period, in event of failure of genset or related components that would prevent genset from being able to connect on-line and supply full rated power to emergency power system, a temporary genset of equivalent size to failed genset to be provided and connected on site to main building power distribution system. Include for required connections, cabling, mechanical protection to cables, programming and any other associated costs and work for such implementation. Temporary replacement genset to be brought to site when permanent genset (specified under scope of this specification) is expected to be out of service for greater than 12 hours, and to be brought to site within 4 hours of failure of permanent generator set.

1.4 **NOISE & EMISSIONS APPLICATIONS**

.1 Coordinate with emissions Consultant and provide necessary technical data and assistance for obtaining required approvals and/or certifications from and//or registration with Ministry of Environment (MOE) for Environmental Compliance Approval.

Part 2 - Products

2.1 **ENGINE GENERATOR SETS-GENERAL**

.1 Engine generator sets (gensets) to be factory assembled and tested, radiator cooled, diesel engine driven electric gensets including necessary controls and accessories as outlined herein, to comprise a continuous, standby electric generating plant for operation in conditions stipulated below. Gensets to be equipped with necessary operating accessories such as air cleaner, radiator fan, lubricating oil pump, governor, alternating current generator and other specified and required engine driven components and accessories.

.2 Base design gensets: _____ model _____, genset that complies with specification requirements and drawing requirements and which may be customized to meet herein specified requirements.

.3 Gensets to be constructed to and to perform in accordance with local governing authority enforced edition of CSA Standard CAN/CSA C282, "Emergency Electrical Power Supply of Buildings".

.4 Gensets to be constructed to and to perform in accordance with local governing authority enforced edition of CSA Standard Z32, "Electrical Safety, and Essential Electrical Systems in Health Care Facilities".

.5 Where requirements of preceding standards and specification are in variance, more stringent requirement is to apply unless otherwise approved by Consultant.

.6 Genset emissions to meet required EPA exhaust Tier limits based upon engine maximum horsepower rating and any other required Ministry of Environment regulations.

.7 Gensets to comply with mechanical systems base design parameters (i.e.. fuel consumption, cooling operating data, air/exhaust operating data, etc.) to ensure that design minimum standards and performance criteria for units are met. Review room dimension and layouts and ensure that proposed gensets and associated equipment can be accommodated and also allow for sufficient space for maintenance, repairs, and safety as per applicable code requirements. Advise Consultant of any changes due to Manufacturer changes in equipment, and/or changes in manufacturers. Be fully responsible for provision and co-ordination of a designed solution that can meet design intent, space limitations, and performance requirements with no additional costs to Contract. Co-ordinate changes with Mechanical Division, as required.

.8 Base designed performance criteria include:

.1 cooling system airflow (max. @ rated speed for radiator arrangement): _____ m^3/min;

.2 exhaust system combustion air inlet flow rate: _____ m^3/min;

.3 exhaust system exhaust gas flow rate: _____ m^3/min;

.4 heat rejection to atmosphere from generator: _____ kW;

.5 maximum fuel return line restriction: _____ kPa;

.6 fuel flow at rated load: _____ litres/hr;

.7 coolant capacity with radiator: _____ litres.

.9 Ensure that genset driven radiator fan is capable of overcoming a minimum of 0.75" water column pressure drop in an ambient temperature of 50°C (122°F). Be responsible for reviewing complete air intake and exhaust system design with regards to air restrictions and if required, provide oversized fans with blades of extra strength to overcome additional pressure drop through fresh air intake, discharge silencers, and other related factors, as applicable. Identify clearly on shop drawings that this requirement has been met.

.10 Where eventual supplied genset(s) provides performances that are different from base designed genset, and such differences exist only due to differences in product manufacturers, be responsible for providing required revisions, i.e. increasing sizing of exhaust piping, air dampers, etc., and related architectural and structural changes. At shop drawing submission stage, submit detailed genset performance data to Mechanical Division contractor to confirm mechanical equipment sizing and to make necessary revisions. Be responsible for costs for such revisions.

.11 Genset ratings:

.1 Rating of engine generator is as noted on drawings, which is at 0.8 power factor and includes 10% overload.

.2 Rating to be nameplate rating.

.3 Capable of operating at 100% of nameplate rating at rated RPM in an ambient temperature of 50°C (122°F) without overheating, or suffering any other detrimental effects, at rated generator RPM when set is equipped with necessary operating accessories.

.4 Capable of handling a single full load step for nameplate kilowatt rating within voltage and frequency regulation requirements of CSA 282/CSA Z32 without stalling and without voltage dropping below 60% of nominal.

.12 Genset to meet frequency and voltage performance requirements specified in CSA 282/CSA Z32.

.13 Genset to be fully integrated to comprise a standby power system which automatically does following:

.1 start in event of a commercial power failure;

.2 stop when commercial power has been restored;

.3 be capable of operating at light loads for an extended period of time as normal power failure may occur when only part of full output of genset is required;

.4 synchronize and parallel with other genset(s) to allow for customized programmed load control as directed and approved by Consultant.

.14 Moving parts such as flywheels, pulleys, belts, etc., to be enclosed with suitable guards to protect persons from injury. Guards to be easily removable for servicing equipment and are to comply with local governing authority and code requirements.

.15 Genset supplier to obtain torsional approval of entire assembly from engine manufacturer. Align and mount genset on a common fabricated steel base of sufficient rigidity to maintain adequate alignment. Set manufacturer to supply adjustable steel spring vibration isolators. Include also for seismic restraints to comply with local governing authority and code requirements. Provide torsional vibration analysis and critical vibration analysis of genset and submit results to Consultant for review.

.16 Genset manufacturer to review engine exhaust system design and confirm in writing that back pressure will not impair operation and output of sets. Forward a copy of confirmation letter to Consultant.

.17 Genset supplier is responsible for but not limited to provide following:

.1 genset(s) and control panels;

.2 fully integrated synchronizing and paralleling control panels;

.3 where applicable, modifications to existing genset to allow for integrated synchronization and paralleling, unless otherwise noted;

.4 system sequence of operation complete with software;

.5 coordination with other trades and systems to ensure proper integration;

.6 exhaust system silencer;

.7 genset and full systems demonstration, testing and verification work;

.8 operating and maintenance instructions.

.18 Review room dimension and layouts to ensure proposed gensets and associated equipment can be accommodated and allow for sufficient space for maintenance, repairs, and safety, as per applicable code requirements.

.19 Arrange for supplier to review electrical distribution system and ensure that genset grounding provisions are compatible and meet local governing electrical code requirements.

2.2 **ENGINES**

.1 Engines to be a multi cylinder, 4-cycle, engine capable of operating at a nominal speed of 1800 RPM when directly connected to generator and free from critical vibrations throughout its entire operation range. Engines to operate satisfactorily on No. 2 diesel fuel and produce specified rated output.

.2 Engines to be complete with inter changeable cylinder heads, exhaust valves constructed of special alloy steel, and stellite faced exhaust valve inserts. Lubricating systems to be full pressure oiling type through internally mounted, high capacity, positive displacement type gear pumps with adjustable pressure regulators, lubricating oil cooler and full flow oil filters. Full pressure lubrication to be provided to main bearings, connecting rod bearings and camshaft bearings.

.3 Provide drain canisters on air boxes for engines.

.4 Equip engines with an electronic governor with speed control and magnetic pick up assembly capable of maintaining speed and voltage regulation within limits previously specified. Electronic governor to be of type recommended by genset manufacturer to provide performance to suit specific application.

.5 Equip engines with an electronic governor with speed control and magnetic pick up assembly capable of maintaining speed and voltage regulation within limits previously specified. Governor is capable of synchronization and paralleling to perform load control (sharing and shedding), kW and KVAR sharing, in standalone operation, and in concurrent with other gensets. Governor controls speed or load of generator sets. Control provides isochronous (zero droop) operation, with a provision for adjustable droop control / operation. Include also for load sharing module complete with required voltage and current transformers. Ensure that gensets are provided with requirements to fully connect and integrate to these controls.

.6 Electronic governor selected interfaces directly with auxiliary controls that ramp, at a user defined rate, between low idle and rated speed settings via a selector switch, where ramp times are to be adjustable from 1-22 seconds. Control adjustments, including Gain, Reset, and Actuator Compensation, are to be accessible from front of control. Governor integral failed signal detection circuit constantly monitors signal from a magnetic pickup unit. Frequency regulation to be adjustable between 0-5%, while steady state regulation bandwidth is not to exceed ± 5%.

.7 Provide synchronizing controls complete with required potential transformers. Control provides automatic frequency and phase matching when used with speed control electronic governor and load sharing controls. Synchronizer functions include speed bias circuit, enable circuit, breaker close circuit and voltage comparator circuit. Features include adjustable dynamics, frequency, phase and voltage matching, selectable match up time, automatic breaker closure, and selectable output impedance.

.8 Equip engines with 12/24 Volt DC electric starting motors, with starting pinion arranged to disengage automatically when respective engine starts.

.9 Equip engines with individual safety devices to shut down engine and to sound an alarm in event of conditions specified later in this Section. Provide contacts to pre-alarm for conditions specified later in this Section. Refer to control panel requirements specified elsewhere in this Section and requirements as detailed on drawings for additional requirements. Provide sensors to connect to electronic controls to monitor and display various engine performance characteristics.

.10 Filters on air intake to engine are of dry vortex type with replaceable elements.

.11 An integral shock isolated mounted emergency lock out stop pushbutton, oil temperature gauge, oil pressure gauge and engine coolant temperature gauge are provided on engine.

.12 Engine mounted accessories are readily removable without dismantling engine alternator, or any other accessories.

.13 Provide factory installed custom fitted high temperature blanket-type insulation on manifolds and extending up to and including flexible exhaust pipes.

.14 Provide "Aeroquip" or equivalent wire braided engine oil extension hoses on oil drain to extend out for easier access. Clip to side of base with proper clips.

.15 Provide brass type oil drain valves.

.16 Extend oil fill pipe out beyond protection screens to allow for easier access.

.17 Provide lube oil level gauge switch on side of oil pan in easily accessible location.

.18 Extend fan hub grease fitting out beyond hub housing, for easier service.

.19 Pipe engine oil drain out to engine base.

2.3 **ALTERNATORS**

.1 Alternator features include following:

- .1 voltage rating as noted on drawings;
- .2 drip proof, single bearing and close coupled to engine with an SAE housing;
- .3 2/3 pitch;
- .4 maximum total harmonic distortion of voltage waveform is not to exceed 6.0% under any given load;
- .5 excitation boost not less than three (3) times rated current for 10 seconds;
- .6 direct connected brushless exciters; rotating brushless permanent magnet pilot exciter to provide power via automatic voltage regulator to main exciter, and with dynamically balanced rotor permanently aligned to engine by SAE flexible disc coupling;
- .7 full amortisseur windings;
- .8 windings of Class H rating;
- .9 temperature rise not to exceed 130°C as measured by resistance in an ambient temperature 50°C (122°F);

.10 meet or exceed CSA 22.2 No. 100, EEMAC MG 122 and current IEEE Standards;

.11 grounding provisions to suit electrical distribution system.

.2 Extension boxes on alternators to be of sufficient size to accommodate "Corflex II" cable and a current sensor for ground fault protection as specified in control panel hereinafter. Connection boxes to be manufactured to isolate "Corflex II" cable specified from set and prevent transmission of vibration. "Corflex II" cables installation to utilize non-ferrous ground bushings. Cable is generally as sized on drawings, but in absence of direction, size conductors in coordination with genset supplier to suit application and local governing electrical code requirements. Alternative cable in conduit arrangements may be proposed for use subject to review and acceptance by Consultant.

.3 Voltage regulation systems are to maintain regulation within limits previously specified and include regulator and manual voltage adjustment potentiometer. Regulator to be a Basler type SR4 or Newage-Stamford no. MX321 or equivalent as recommended by genset manufacturer, static voltage regulator with 3 phase sensing, radio suppression module, frequency choke to prevent damage to voltage regulator in case of lower than nominal engine speed, and adjustable stability circuit.

.4 Equipment is designed to minimize Radio Frequency Interference (RFI) under all operating conditions. "Balanced Telephone Influence Factor" (TIF) is not exceed 50.

.5 Extend alternator ground out to base.

.6 Alternator is equipped with Resistor Temperature Detectors (RTD) type thermistors complete with required relays/contacts as required to send trouble signal to control panel. Control panel to monitor warning signal of high temperature of windings.

2.4 ENGINE FUEL SYSTEM

.1 Fuel injectors for engine are individual cylinder type, capable of quick replacement. Dual prime fuel filters are complete with receptacle elements, which can be easily removed without disturbing other parts of engine. Where required for proper system performance, genset to be complete with integral mounted auxiliary tank.

.2 For each genset provide two (2) fuel oil flexible connectors with braided stainless steel covering, diameter to suit engine requirements and minimum 900 mm (36") long.

.3 Fuel lines to be 2 hour rated, flexible braided jacketed, high-pressure lines suitable for use with type of engine fuel, and complete with male swivel fittings.

.4 Provide a water separator assembly on genset consisting of water sensor complete with gauge, fuel restriction sensor, alarm contacts to send signal to genset control panel, required relays and filter.

2.5 ENGINE EXHAUST SYSTEM

.1 Engine exhaust system to consist of lengths of flexible stainless steel exhaust pipe, exhaust silencers and rigid exhaust piping. Each flexible exhaust pipe to be a minimum of 600 mm (24") in length but, sized for thermal expansion and engine vibration. Unless otherwise specified or directed by noise and emissions Consultant, silencers are to be equivalent to Silex "Hospital Plus" series JDDPR type to provide highest degree of noise reduction and to suit each respective size of genset. Both flexible pipe and silencer are suitable in all respects for application and be as recommended by genset supplier to meet design requirements identified in Mechanical and Electrical Divisions Documents. Review issued Documents and supply appropriate silencers. Turn over silencers and flexible stainless steel piping to Mechanical Division for installation. Acceptable manufactures of silencers are Silex Inc., Vibron Ltd., Nelson, and Maxim.

.2 Rigid exhaust piping and exhaust stack is responsibility of Mechanical Division.

.3 As applicable to design of engine, supply a properly sized black steel pipe welded "Y" connection with two (2) lengths of flexible stainless steel exhaust pipes installed between engine and "Y" connection. "Y" fitting and flex connections to be turned over to Mechanical Division for installation.

.4 Be responsible for coordination with mechanical trades, exact silencer and exhaust system design requirements to comply with local governing noise and emission regulations. Height of stack to be provided to suit local air and noise limitations.

.5 Routing of exhaust piping is generally diagrammatic and shows approximate routing and locations. Ensure that Mechanical Division provides fittings, offsets, transformations and similar items as a result of obstructions and other Architectural or Structural details whether shown or not on drawings.

.6 Coordinate final diameter of exhaust piping and stack with performance requirements of final supplied genset and site conditions of exhaust system routing.

2.6 JACKET COOLANT HEATERS

.1 Engine jacket coolant heaters to be complete with silicone hoses, immersion type thermostats, pressure switches and ball type-isolating valves on engine water connections. Size of heaters to be sufficient to maintain coolant in engine at genset Manufacturer rated temperature requirements with unit operating at rated loads and conditions (approximately 6 kW, per engine at 208 V, 1-phase, but confirm with genset vendor and revise to suit).

.2 Jacket heaters to be automatically disconnected when engines are running via oil pressure switches/engine run relay.

.3 Heaters to be KIM "Hotstart" or approved equal, that connect to each engine with high temperature coolant rubber hoses and clamps, specifically used for and approved by governing authorities for such applications.

2.7 COOLANT SYSTEM

.1 Cooling system for engines consists of unit mounted air water radiator system with protective screen and a 50% water/50% ethylene glycol coolant solution. Radiator is equipped with integral fuel cooler complete with fuel lines, power conductors, control conductors, and ancillary devices as required.

.2 Thermostat maintains coolant temperature at Manufacturer rated temperature with genset operating at rated load. Radiator is sized to maintain these conditions and is complete with high performance static pusher fan, fan motors, radiator core guard, duct adapter flange, mounting frame, expansion tank, thermostatic controls, disconnect switch, a suitable open mesh fan guard and shroud.

.3 Gate drain brass ball valves are provided for draining coolant from each engine block and radiator. Wire braided hoses, piping and fittings to be silicone and are to extend into drain containment pan under genset.

2.8 STARTING SYSTEM

.1 Supply a complete starting system for engine, including:

- .1 cranking starter motors;
- .2 batteries;
- .3 battery heater;
- .4 battery stand with insulation board;
- .5 battery cable;
- .6 battery chargers;

.7 cranking motor cut-out switch (crank for three (3) attempts with intervening periods during a period of no less than 45 seconds and no more than 75 seconds).

.2 Batteries features include:

.1 fully sealed, long life lead acid;

.2 Exide, Delco or equivalent with sufficient capacity in an ambient room temperature of 0°C (32°F) to crank each unit at engine Manufacturer recommended cranking starting speed for a period of 60 seconds;

.3 voltage measured at starting motor terminals at end of cranking period specified above, with cranking current flowing, to not be less than 1.75 volts per cell;

.4 sized on basis of engine and battery Manufacturer published data;

.5 type and performance ratings as recommended by genset supplier and approved by Consultant to best meet starting requirements of specified genset.

.3 Submit shop drawings and reasons to substantiate choice of batteries.

.4 Batteries to be provided on a floor standing, corrosion resistant finished, steel rack, complete with following:

.1 hydrometer;

.2 syringe;

.3 jumper cables;

.4 mounting bracket for accessories;

.5 plywood base;

.6 PVC tray.

.5 Battery chargers to be Vulcan Electric Ltd. or equivalent as recommended by genset supplier, with features as follows:

.1 remote wall mounting, totally enclosed enclosure;

.2 fully automatic operation;

.3 operating voltage of 115 volt, 60 cycle AC;

.4 an AC switch and overload protection isolating voltage ratio transformer, silicon controlled rectifier assembly and DC protection, all suitable for two (2) rates of charging (trickle charge and high rate of charge for use after engine start);

.5 DC ammeter and DC voltmeter gauges, each with 2% accuracy;

.6 AC power "on" indicating light;

.7 AC power failure alarm;

.8 float voltage adjustment;

.9 equalize circuit;

.10 overload protection;

.11 DC output protection;

.12 maximum charge rate to suit application;

.13 necessary contacts for connection of common alarm signal to control system.

.6 Battery chargers to recharge a battery discharged by two cranking cycles (30 seconds each) to 80% of capacity within 4 hours and to full capacity in maximum 12 hours.

2.9 **ENGINE GENERATOR MOUNTINGS**

.1 Engine flywheel housing to be connected rigidly to generator housing with an SAE adaptor. Unit to be mounted on a common, heavy duty, stress relieved, fabricated steel baseplate. Torsional approval of entire assembly to be obtained and submitted in duplicate to Consultant for review. Report to also outline critical speeds of assembly.

.2 Baseplates to be of sufficient rigidity to maintain alignment of engine generator shafts and frames under all conditions during shipping, installation and service and be of all welded construction without bolt on components.

.3 Engine generator feet and baseplate sole plates to be machined parallel and true. Shimming to be of steel type and only be permitted underneath generator feet.

.4 Baseplate to be supported on spring type vibration isolators. Isolators to have cast iron housings and be complete with levelling bolts, adjustable oil proof snubbers and minimum 6 mm (1/4") thick sound pads. Isolation efficiency to not be less than 95%. Provide Kinetics "FLS" Series or equivalent Korfund type.

.5 Isolators to be strategically located in a manner to ensure that each isolator will carry an equal portion of weight and that pressure exerted on structure by each isolator does not exceed 345 kPa (50 psi).

.6 Comply with local governing authority and code requirements with regards to seismic restraints. Provide necessary materials and certification by local authority.

2.10 **UNIT MOUNTED CONTROL PANELS**

.1 Control panels consist of a microprocessor based controller with LCD displays featuring multiple metering displays and graphics, with full options and features as specified herein, and is suitable for operating on system voltage rating noted on drawings, with short circuit capacities to suit maximum short circuit output of alternator.

.2 Control panel in enclosure is unit mounted on I-beam support base, vibration isolated from genset, and is complete with monitoring devices, meters, indicators, display and interconnecting/interfacing devices. Digital metering and displays are mounted at eye level. Control panel enclosure is painted with enamel to match genset finish.

.3 Controls and monitoring include but are not be limited to following components:

.1 under frequency/over voltage control module with adjustable relay to trip main breaker on settings of ±12% of normal;

.2 ammeter m ±-1% accuracy;

.3 voltmeter ± 1% accuracy;

.4 power factor meter;

.5 frequency meter ± 1% accuracy;

.6 elapsed time ± 1% accuracy;

.7 engine gauges for oil temperature, oil pressure and engine coolant temperature;

.8 kW meter ± 1% accuracy;

.9 control system to initiate genset starting and stopping sequence, and annunciate any fault condition (local or remote indication); an electronic control module monitors and provides digital display of genset functions; an operator interface alpha numeric display provides for viewing of genset data and provides setup, controls and adjustments; a LED bar graph AC data display or approved equivalent is included;

.10 engine selector switch for "OFF AUTO MANUAL" operation; operation of engine in manual position, when selected, bypasses automatic control system and causes an alarm to occur; switch in "OFF" position causes an alarm to occur; switch in either "OFF" or manual position causes amber indicator lamp identifying "NOT IN AUTO" to illuminate when alarm occurs;

.11 alarm horn with silencing button, and an annunciator to flash when any audible alarm is silenced until trouble has been cleared and reset;

.12 miscellaneous controls as shown on drawings and as required including voltage and speed control, emergency stop, fault reset, lamp test, engine start, engine stop and indicating lights;

.13 engine alarm and shut down lamps with signals for conditions specified later in this Section and/or as shown on drawing and as required by local governing authorities having jurisdiction; provide engraved lamacoid identification nameplate for each lamp; provide panel with lamp test button;

.14 required secondary and control wiring, type "TEW" 105°C rated, extra flexible wire with thermoplastic insulation and an overall flame retarding cotton braid, neatly harnessed, suitably secured and identified with slip on identification markers; Wiring to be colour coded to suit application and standards; wiring for DC supply to control panel, wiring for cranking circuits and wiring for air box damper to be minimum number 10 AWG stranded; wiring within control panel to be number 16 AWG stranded; and wiring between control panel and engine generator set and transfer switch to be number 14 AWG stranded; provide separate junction boxes for AC and DC wiring;

.15 ground fault relay to alarm on control panel in event of a ground fault on windings of generator; current sensor to be mounted in generator connection box, and generator leads to pass through zero sequence circuit in connection box ; no internal ground connection in generator is permitted, and an annunciator light to be provided on control panel face to indicate operation of this device; ground fault setting to be determined by genset manufacturer to suit specific application;

.16 current transformers as required of appropriate size for local metering;

.17 current transformers as required for electronic governor;

.18 24 volt DC control system with fusing centrally located;

.19 required potential transformers;

.20 auxiliary contacts on all devices to allow for functions required in controls system and interconnection to integrated systems such as fire alarm and building automation system;

.21 other components as shown on drawings and as required.

.4 Breakers mounted in control panel integral with genset include following features:

.1 moulded case type main breaker: Fixed mounted moulded case circuit breaker as shown on drawings and as required, with solid state adjustable trip unit. In absence of direction, size and ampacity of breaker to be to suit application based on code requirements and genset Manufacturer recommendations. Breaker setting to be such that generator short circuit output will trip breaker. Trip unit to include adjustable long, short, instantaneous, time delay and ground fault alarming. Exact settings to be determined by genset manufacturer to meet specific applications. Exact breaker type to be as recommended by breaker and genset manufacturer to meet such applications and be approved by Consultant;

.2 power air circuit type main breaker: Eaton 'Magnum DS' type or equivalent Schneider "Masterpact NW" or Siemens "RL" type, fixed mounted electrically operated air circuit breakers as shown on drawings and as required, with solid state adjustable trip unit. In absence of direction, size and ampacity of breaker to be to suit application based on code requirements and genset Manufacturer recommendations. Breaker setting to be such that generator short circuit output will trip breaker. Trip unit to include adjustable long, short, instantaneous, time delay and ground fault alarming. Exact settings to be determined by genset manufacturer to meet specific applications. Exact breaker type to be as recommended by breaker and genset manufacturer to meet such applications and be approved by Consultant;

.3 moulded case load bank breaker: Non automatic type, of same frame size as main breaker, to be provided interconnected to system to allow for connection of a load bank during regular testing of genset; provide shunt trip and relays as required to interconnect in manner such that if load bank breaker is closed and loss of normal power occurs, load bank breaker will open and main genset breaker will close;

.4 fire pump breaker: Moulded case type with solid state trip unit; refer to drawings;

.5 auxiliary automatic breaker (typically 30A-3P, but refer to drawings for exact requirements) to feed damper controls and fuel oil pumps; confirm exact requirements with Consultant prior to ordering.

.5 Electronic controls to be capable of monitoring various engine performance characteristics including, but not limited to, following:

.1 oil and fuel temperature;

.2 coolant pressure and level;

.3 oil and fuel pressure;

.4 running hours;

.5 air temperature;

.6 battery voltage;

.7 engine overspeed.

.6 Genset synchronizing and paralleling components includes following, in addition to any other required components:

.1 synchronizer and synchroscope;

.2 solid state sync check relay;

.3 synchronizing switch and controls;

.4 synchronizing lights;

.5 reverse power relay and accessories;

.6 PLC with software to provide complete automation control system as per specification requirements later in this Section.

.7 Provide controls, contacts and annunciation of shut downs (red) and warnings (amber) alarms for following conditions, conditions as per applicable CSA Standards and conditions as detailed on drawings:

.1 high oil temperature - red;

.2 high oil temperature warning - amber;

.3 high coolant temperature - red;

.4 low oil pressure warning - amber ;

.5 low oil pressure - red;

.6 overcrank - red ;
.7 overspeed - red;
.8 over voltage - red;
.9 low DC voltage - amber (alarm lamp complete with DC voltage sensor);
.10 cool down period - white;
.11 reverse power - red;
.12 undervoltage - red;
.13 low frequency - red;
.14 high frequency - red;
.15 low coolant level - amber;
.16 low fuel level - amber;
.17 battery charger failure - amber;
.18 water in fuel - amber;
.19 emergency bus alive - blue;
.20 generator bus alive - amber;
.21 ECS not in auto - amber;
.22 low engine temperature - amber;
.23 alarm silence - amber;
.24 alternator winding and bearing high temperature - amber;
.25 fuel leakage - amber;
.26 ground fault - amber;
.27 ancillary building alarms as required;
.28 two spares for future.

.8 Utilize high brilliant cluster type LED's for indicating lights that are continuously illuminated "ON".

.9 Provide required type of contacts, wiring and connections to auxiliary building systems for applications as noted in Part 3.

.10 Provide engraved lamacoid nameplate of each control operator, device, and indicating light. Obtain Consultant's approval of exact nomenclature.

.11 Designer/manufacturer of entire control system is required to:

.1 supply complete design, erection and layout drawings for system, indicating all wiring requirements, interfacing or interconnection provisions required to completely integrate controls with all remote apparatus;
.2 assemble, wire and pre-test system components prior to shipment to site; such tests to be witnessed by Consultant at their discretion; all defects noted and corrected, and system retested prior to leaving plant;
.3 assist in installation and oversee work to ensure that it meets with requirements;
.4 carry out a site test of system in conjunction with other components in standby power system and demonstrate its power operation to satisfaction of Consultant.

2.11 EMERGENCY SWITCHBOARD

.1 Emergency switchboard is to be provided by genset supplier and which include for general requirements as specified for switchboards in Section titled Secondary Switchboards and as detailed on drawings. Manufacturer of switchboard and breakers to be same as successful manufacturer of switchboards of Section titled Secondary Switchboards. Refer to Section titled Secondary Switchboards for additional requirements.

.2 Switchboard to include synchronization and paralleling controller, controls, components and software.

.3 Provide switchboard cubicle/cell construction, breakers, bus bars, ground bus, terminations, conductor connection facilities, nameplates, mimic bussing; controls and other components as per switchboards specified in Section titled Secondary Switchboards.

.4 Breakers to be draw-out type/fixed mounted electrically operated air circuit breakers. Automatic breakers to be complete with solid state adjustable trip unit. Breaker to be as shown on drawings and as required, but in absence of direction, size and ampacity to suit application based on code requirements and genset Manufacturer recommendations. Breaker setting to be such that generator short circuit output will trip breaker. Trip unit to include adjustable long, short, instantaneous, time delay and ground fault alarming. Exact settings to be determined by genset manufacturer to meet specific applications and coordination study specified in Section titled Electrical Work Testing. Exact breakers type to be as recommended by breaker manufacturer to meet such applications and be approved by Consultant.

.5 Include for ground fault protection as required for system and as per genset Manufacturer recommendations and which include required current transformers (CT's), ground fault relays and secondary CT wiring to suit specific application.

.6 A non-automatic moulded case load bank breaker (same frame size as main breaker) to be provided interconnected to system to allow for connection of a load bank during regular testing of genset. Provide shunt trip and relays as required to interconnect in manner such that if load bank breaker is closed and loss of normal power occurs, load bank breaker to open and main genset breaker to close.

.7 Provide fire pump breaker of moulded case type with solid state trip unit. Refer to drawings.

.8 Switchboard bussing to be copper and extended to accept connections to interconnecting cables.

.9 Switchboard to be complete with required control wiring and terminal blocks. Control wiring to be neatly harnessed and suitably secured.

2.12 ADDITIONAL ENGINE GENERATOR SET REQUIREMENTS

.1 Supply with engine generator set, a soldered galvanized steel drip pan to be placed beneath engine to catch any leakage from set.

.2 Supply tools and spare parts required for normal maintenance and adjustment of genset, including:

.1 one (1) complete set of fuel oil filter elements complete with gaskets;

.2 one (1) complete set of lubricating oil filter elements complete with gaskets;

.3 one (1) complete set of air filters;

.4 two (2) complete sets of spare fuses;

.5 two (2) complete sets of spare lamps for all indicating and warning lights;

.6 one (1) complete set of spare belts;

.7 one (1) steel cabinet for storage of manuals and spare parts; cabinet to be wall mounting complete with shelves, hinged doors, lock and key set.

.3 Submit sound pressure levels for engine generator set to Consultant for review and acceptance, prior to units being shipped to site.

.4 After on-site successful testing, touch up paint genset(s) with manufacturers supplied paint. An additional one (1) litre of touch up paint must be shipped loose with each unit and turned over to Owner. Paint control panel with corrosion resistant enamel paint to match genset finish. Note: exact finishes are to be confirmed with Consultant prior to ordering of paint.

.5 Genset manufacturer/supplier is responsible for factory testing and on-site testing of genset, as specified in Part 3 of this Section.

.6 Include costs for provisions to duct/drain/filter all waste emissions/leaks, to satisfaction of Consultant. Under no circumstances are waste emissions or waste fluids to be released into room. Provide proper ducting/piping/filtering.

2.13 EMERGENCY POWER OFF (EPO) PUSHBUTTONS

.1 Rockwell Automation - Allen-Bradley, 800T Series, 55 mm (2-1/4") diameter red mushroom head pushbutton with shroud, thrust washer, and an aluminum faceplate with "EMERGENCY POWER OFF" identification lettering. Provide STI type flip open polycarbonate tamper-proof cover. Confirm exact nomenclature with Consultant prior to ordering.

.2 Mushroom head, minimum 38 mm (1-1/2") diameter, exterior remote mounted emergency power off (EPO) station with hinged framed break glass cover with locking handle operator, mounted on exterior wall of enclosure; lock operator to be keyed to Owner requirements.

.3 Acceptable manufacturers are Rockwell Automation (Allen-Bradley), RCI, Schneider Electric and GE.

2.14 TESTING, START-UP, VERIFICATION & TRAINING

.1 Refer to Part 3 for additional requirements.

.2 Assist installing Contractor in installation of equipment and to inspect installation, test equipment, perform start-up and verify equipment. Coordinate work with Contractor.

.3 Be present to assist during third party testing.

.4 Perform testing at times coordinated with Consultant.

.5 Provide instructions on system operating and maintenance.

2.15 ACCEPTABLE MANUFACTURERS/SUPPLIERS

.1 Selected engine-generator sets to be provided from listed approved genset suppliers and be packaged sets that are factory assembled, factory type tested and warranted together.

.2 Acceptable genset suppliers are:

.1 Cummins Eastern Canada LP;

.2 Toromont Cat. Ltd.;

.3 WAJAX Power;

.4 Generac.

.3 Acceptable alternator manufacturers are:

.1 Newage Stamford;

.2 Caterpillar;

.3 Marathon.

.4 Acceptable engine manufacturers are:

.1 Cummins;

.2 Caterpillar;

.3 MTU - DDC.

.5 Main breakers to be of same manufacturer as accepted switchboard supplier of Section titled Secondary Switchboards to maintain continuity of supply for standardization.

.6 Products to be provided must be CSA approved and labelled, or inspected and approved by Electrical Safety Authority.

2.16 **LOAD BANK & TEMPORARY GENSET CONNECTION BOX**

.1 Load bank and temporary genset connection box to be provided to accommodate easy exterior connections to emergency power distribution system and to be as detailed on drawings and as follows:

.1 CSA approved, minimum NEMA 3R weatherproof steel construction, with corrosion resistant enamel finish of colour to Consultant's direction;

.2 with hinged gasketted door with 3-point latch and key lock with provisions for safety padlocks; key can only be removed when door is closed and locked;

.3 conduit entries with proper bushings and sealed to prevent egress of precipitation;

.4 tin plated copper bussing for cable tap off provisions with holes in each bus to accommodate feeders from distribution system; each lug on feeders to be dual annular crimped, long barrel and two hole type, bolted to bussing with 13 mm (1/2") bolts with lock washers, nuts and flat washers; bus to be angled to properly facilitate connection of cabling;

.5 temporary cable connections to include minimum 8-13 mm (1/2") diameter holes in each buss to accommodate single hole lugs;

.6 provide engraved lamacoid nameplate and signage on enclosure with appropriate instructions regarding use; submit proposed scheme and nomenclature with shop drawings.

.2 Mounting requirements to be coordinated with Consultant to suit wall construction where box is to be installed. Obtain direction from Consultant whether box is to be surface or flush mounted. Where flush mounted include flush trim.

.3 Complete assembly to be approved by local governing electrical authorities and suitable for intended application.

Part 3 - Execution

3.1 **INSTALLATION OF GENSET**

.1 Prior to start of Work, prepare schedule of Work and submit to Consultant for review. Manufacturer/supplier to upon successful factory witness testing of unit, arrange and coordinate delivery and transporting of unit to site.

.2 Perform a factory test of engine generator sets prior to delivery to job site. Include for and arrange for Owner and Consultant to witness factory tests and schedule tests at a time acceptable to Owner and Consultant. Include "out of town" expenses such as transportation, lodging, meals, etc., for Owner and Consultant to witness factory testing. Notify Owner and Consultant at least two (2) weeks in advance of tests. Should additional tests be required due to failure to comply with conditions specified in this article, costs (all travel expenses, accommodation if required, plus seven hundred and fifty dollars [$750.00] per day) for Consultant to witness these additional tests are to be borne by genset manufacturer/supplier. genset manufacturer/supplier to be responsible for full arrangements. Tests to include period(s) of minimum 4 hours continuous operation under full load conditions as directed by Consultant. Number of periods of testing to be quantity as required until successful testing of specified requirements to satisfaction of Consultant and Owner. Ensure that proper 100% capacity resistive type artificial load banks are available for tests. Factory testing to include use of strip chart recording instruments to confirm that engine generator set complies to specified requirements in frequency, voltage and current regulation as specified herein this Section. Testing to also be performed to demonstrate successful synchronization and paralleling. Submit reports for Consultant review and obtain Consultant approval prior to shipping gensets to site.

.3 Review site conditions, room accessibility, dimensions, etc. and note applicable restrictions. Disassemble genset if required to move into room and into installation space. Each disassembled part must be labelled, numbered, and documented. Engage genset manufacturer to supervise and perform disassembling and reassembly work and to provide necessary technical assistance.

.4 Provide hoisting of gensets as required to locate into position.

.5 Coordinate controls work both at factory and on site and include for required interface work to existing equipment on site.

.6 Provide gensets and system control components where required to generate emergency power. Transport/hoist gensets into location. Concrete base to be generally sized minimum 300 mm (12") larger extending out around footprint of container. Refer to structural drawings for additional requirements including seismic requirements.

.7 Secure genset on vibration isolation springs to its base by means of 13 mm (1/2") diameter "Rawstud" high tensile strength steel anchor bolts. Ensure that set is plumb and level. Check engine generator alignment when mounting is complete. If necessary, realign in accordance with Manufacturer recommendations.

.8 Install a galvanized steel drip pan under each engine. Supply pans loose with sets.

.9 Secure various control panels and switchboard in place on concrete housekeeping pads. Connect complete. Connect alarm/trouble contact points to respective genset and other equipment alarm contacts, with required wiring in conduit. Include for Work to ensure interconnections for control, alarm, monitoring, and supervision of all functions of control panel and systems. As applicable, make necessary interconnections to transfer switches to initiate emergency power sequence of operation. Check and test control panel functions. Provide breakers as required and check and test switchboard, breakers and control panel functions. Adjust as required. Programme PLCs as required. Refer to installation requirements of switchboards in secondary switchboards article.

.10 Provide power panel with dedicated breakers and feeders in conduit to serve various genset equipment, accessories and integrated components controlling auxiliary building systems. Exact breaker ratings and power requirements to suit final installed equipment. Connect complete with required wiring in conduit. Provide engraved nameplates for each control panel and component. Provide detailed operational and warning signage. Confirm exact nomenclature in writing with Consultant prior to manufacture.

.11 Provide required power feeders, control wiring, communications wiring and make required connections to genset with suitable cabling and lugs. Connect to building distribution system as coordinated with Consultant. Extend required feeders to genset. Connect and ground unit with proper copper ground conductors. Connect feeders to panel and ensure that all components and accessories that require external power are fed from panel breakers, as required. Identify breakers in panel. Extend control/communications wiring in conduit to BAS and fire alarm system, as required.

.12 Provide system of cable tray and Unistrut Corporation channel support system for overhead-suspended "Corflex II" cable. Support system consists of cable trays supported by channels, supported by suitable threaded steel rods secured to structure with suitable aluminium clips. Tie wraps are not acceptable for securing "Corflex II" cables. Utilize non-ferrous single screw cable clamps. Provide required cable support system accessories which are not specified herein or shown on drawings but are required for proper installation.

.13 Provide "Corflex II" conductors as specified from alternator to control panel. Ensure that conductors are properly isolated from engine generator sets and that final connections are made with flexible couplers.

.14 Ground and bond single conductor "Corflex II" cables at both ends where sheath currents do not affect cable ampacity. For certain areas, where sheath currents will reduce cable ampacity, ground and bond cable at supply end and isolate cable at load end as recommended by cable manufacturer, and provide a No. 3/0 green TW ground conductor for each cable run. Ground and bond equipment as per local electrical code requirements. Refer also to requirements of grounding and bonding article.

.15 Refer to and provide additional applicable testing requirements of distribution system testing and coordination study article.

.16 Extend control wiring from engine generator set control panel to starter and control panel for fuel oil pumps such that when engine starts, pump starts and runs continuously for length of time engine is in operation, and such that when engine shuts down pump stops. Check and test starting battery assembly low voltage alarm and monitoring system. Adjust as required.

.17 For initiating start-up upon loss of normal power of electrical distribution system, provide fire rated MI wiring from genset control panel to appropriate transfer switch contacts or to other designated control system loss of normal power signal as confirmed with Consultant, to initialize engine start-up upon loss of normal power.

.18 Extend control wiring from engine generator set control panel to generator room fresh air intake dampers such that when engines start dampers open to a minimum setting to provide combustion air to engines.

.19 Provide control wiring in conduit runs, unless MI is used. Comply with local code requirements regarding fire rated conductor applications.

.20 Provide starting batteries, rack, jumper cables, hydrometer, syringe, etc. Connect batteries to engine starting system. Locate where directed by Consultant. Provide mechanical support utilizing metal C-channel framing or conduits to support all cables between batteries, genset and charger.

.21 Wall mount a battery charger adjacent battery rack and connects complete. Check and test charge operations and adjust as required Ensure that batteries are properly charged and have been serviced. Floor mount remote fuel cooler adjacent genset as required and connects complete. Provide dedicated power circuits from designated panel serving area, as required to power devices.

.22 Fill radiator with a solution of 50% clean water and 50% permanent type ethylene glycol. Check specific gravity of engine coolant. Add glycol and/or water if required.

.23 Check level of engine lubricating oil and add if required. Check and test operation of engine starting system, and jacket coolant heaters. Include acoustical testing to verify sound levels during operation at full load.

.24 Supply flexible exhaust piping, exhaust silencers and suitable fuel oil flexible piping connections and turn over to mechanical trade at site for installation. Ensure that exhaust system and fuel oil piping system is provided complete and connected by Mechanical Divisions. Connect and extend signal/control wiring in conduit from fuel level components of fuel tanks to control panel.

.25 Coordinate installation of exhaust system with Mechanical Divisions. Arrange for manufacturer of engine generator set to review engine exhaust system design and confirm in writing that exhaust system back pressure will not impair operation and output of set. Forward a copy of confirmation letter to Consultant.

.26 Check and test operation of engine starting system, and jacket coolant heaters.

.27 Wall mount storage cabinet complete with tools and spare parts.

.28 Ensure that conduit connections to generator set are made with liquid tight flexible conduits.

.29 Provide and connect control panel wiring between fire alarm system and building management system, and if necessary, provide all required low voltage relays, wiring in conduit and contactors from generator control panel to fire alarm system control panel for supervision and annunciation of "Generator Running", "Generator Failure To Start", "Low Voltage Generator Battery" and "Low Fuel Level". Extend and connect these points to BAS. Subject to approval of Consultant, these alarm points may be a common alarm at interconnected fire alarm and BAS systems panels.

.30 Provide wall mounted "EMERGENCY POWER OFF" (EPO) pushbuttons with tamper flip cover, in outlet boxes in locations confirmed with Consultant. Confirm exact locations prior to roughing-in. Connect complete to genset controls as required to shut down genset.

.31 Carefully coordinate installation of set with:

- .1 power and heat generation Work of Mechanical Divisions where fuel oil storage and pumping system and installation of fuel oil flexible connections is specified;
- .2 insulation Work of Mechanical Divisions where exhaust system insulation is specified;
- .3 air distribution Work of Mechanical Divisions where plenum connection to engine radiator is specified;
- .4 exhaust piping Work of Mechanical Divisions where exhaust piping and stack work is specified.

.32 Prepare and submit with engine generator set shop drawings, necessary design, erection and layout drawings, wiring, piping and control diagrams as required for proper execution and completion of Work.

.33 Notify Owner and Consultant minimum 2 weeks in advance of onsite testing. Under direction and in presence of Owner and Consultant, genset Manufacturer authorized technician to provide tests at site on engine generator set when installation is complete, but before acceptance of same. Coordinate with independent distribution system testing company specified in distribution system testing and coordination study article, to ensure that engine generator set performs with emergency power distribution system in accordance to requirements of all applicable CSA Standards.

.34 Coordinate and arrange for Manufacturer trained mechanic to conduct such tests and to make all required changes and adjustments found necessary by such tests. Repeat tests until defects are corrected and equipment operates properly to Consultant's satisfaction. Perform general operational testing and other testing as per CSA Standards and requirements herein specified. Perform full load test, which is to include period(s) of minimum 4 hours continuous operation under full load conditions as directed by Consultant. Number of periods of testing to be as required to successfully demonstrate that genset complies with specified parameters to satisfaction of Consultant and Owner. Testing to also be performed to demonstrate successful synchronization and paralleling. Perform testing with load banks prior to testing with building loads.

.35 Onsite testing to be performed at times acceptable to Owner. Be responsible for costs of additional testing due to failure of genset to perform to specified standards, with additional expenses in effect as specified previously for factory testing. Supply variable load banks and cables sized for 100% capacity of plant, for testing procedure indicated herein.

.36 Include for license electrician to be on site for testing, verification and commissioning Work, to make any required distribution system changes necessitated by Work. Arrange for genset supplier's controls contractor to be present for testing and commissioning.

.37 Upon completion of installation of equipment, by Contractor, equipment manufacturers to inspect installation of each complete equipment assembly and certify in writing to Consultant satisfactory installation and operations of same. Submit detailed list of deficiencies to Consultant.

.38 Obtain approvals from local governing authorities including Technical Standards and Safety Authority (TSSA).

.39 Equipment manufacturers to include for a site visit to inspect, test, perform start-up and verify installation to ensure that installation and Contractor is in compliance with Contract Documents.

.40 Upon acceptance of emergency power plant, arrange for Manufacturer mechanic to instruct Owner operating personnel in correct operation and maintenance of plant. Provide CD/DVD recording of such instruction.

.41 Perform test procedures in accordance with test sheets found at end of this Section. Submit reports signed and bound to Consultant using these typical sheets.

.42 Provide engine generator sets with fuel oil for onsite testing and upon acceptance of tests, prior to turn over to Owner, refill storage tank(s) with fuel oil. Submit copy of signed certificate declaring tanks have been re-filled and amount of fuel filled.

.43 Refer to details and schedules on drawings for further specifications on genset.

3.2 GENERAL TESTING REQUIREMENTS FOR GENSETS

.1 In additional to requirements specified in this Section, refer to requirements of Section titled Electrical Work Analysis and Testing.

.2 Following are general typical guidelines for testing of gensets and controls. Confirm exact requirements Consultant and Commissioning Agent prior to start of work. Additionally, contact genset manufacturer and obtain their recommended testing procedures for specific gensets of this Project. Coordinate with genset supplier.

.3 Refer to and provide additional applicable testing requirements of distribution system testing and coordination study article.

.4 Operational Tests:

.1 With engine in a "cold start" condition and emergency load at its normal operating level, simulate a power failure by means acceptable to Consultant. Do not interrupt existing services unless approved in writing by Consultant. Test load to be load which is normally served by emergency power system. Unless instructed by or approved in writing by Owner and Consultant, do not use building loads for testing. Provide variable load banks sized for loads as required.

.2 Continue operational test for 1 hour, after which time, restore normal power, and demonstrate satisfactory transfer of load and shutdown of emergency generating sets.

.3 Observe and record following data:

.1 time delay on start;

.2 cranking time until engine starts and runs;

.3 time required to come up to operating speed;

.4 time required to achieve a steady-state condition with all switches Transferred to emergency position;

.5 voltage, frequency, and amperes at start-up and at any observed change in load;

.6 engine oil pressure, water temperature where applicable, and battery change rate at 5 min intervals for first 15 minutes and at 15 minute intervals thereafter;

.7 time delay on retransfer for each transfer switch; and

.8 time delay on engine cool down and shutdown.

.4 Full Load Test

.1 Following operational test, subject genset to a 4 hour 100% load test.

.2 Provide variable load bank for testing, unless use of building load is permitted in writing by Owner and Consultant.

.3 Full load test may be initiated by any method that will start engine and, immediately upon reaching its rated speed, pick up full load in one-step.

.4 Record data for items listed above, at first load acceptance and every 15 minutes thereafter until completion of test period.

.5 Cycle Crank Test:

.1 Prevent engine from running by utilizing any method recommended by manufacturer. Place control switch in "run" position to cause engine to crank.

.2 Engage engine starting system to provide a cranking cycle consisting of:

.1 30 seconds of continuous cranking; or

.2 three (3) 10 seconds crank attempts separated by 10 seconds rest periods;

.3 repeat crank cycle a second time to demonstrate that batteries have sufficient capacity for a total cranking time of 60 seconds;

.4 demonstrate time required to recharge batteries to meet requirements.

.6 Safety Shutdown and Alarms:

.1 Test gensets as recommended by manufacturer and as described herein this Section to ensure that safety shutdowns and alarms are fully functional.

.7 Ventilation:

.1 During testing of gensets, demonstrate that sufficient ventilation is provided for room housing gensets, in accordance with requirements of CAN/CSA-C282.

.8 Voltage and Frequency:

.1 Perform this test in accordance to CAN/CSA-C282/Z32.

.9 Oil Analysis:

.1 Perform this test in accordance to CAN/CSA-C282/Z32.

.5 Synchronization and Paralleling:

.1 Modify above testing to properly demonstrate operation of multiple gensets (additional and existing) and their synchronization and paralleling. Outline sequence of operation of emergency power system and demonstrate with detailed tests recommended by genset manufacturer and as acceptable to Consultant and Commissioning Agent.

3.3 NOISE EMISSIONS TESTING

.1 Coordinate for Owner specialist air emissions Consultant to provide testing and required equipment and personnel to verify that complete genset assembly complies with issued documents and requirements with respect to MOE Perform required operating and maintenance of gensets during testing.

3.4 INSTALLATION OF LOAD BANK & TEMPORARY GENSET CONNECTION BOX

.1 Install box as required and secure to main building wall with proper fasteners to suit application. Confirm location prior to roughing-in. Confirm finishes with Consultant prior to manufacturer.

.2 Cut and patch openings in walls as required to accommodate feeders and conduits. Provide required feeders in conduit sleeve through wall. Provide proper sleeving and weatherproof firestopping materials to maintain fire rating of building wall surfaces and caulking to seal openings. Coordinate work with General Trades Contractor.

.3 Extend connection cabling in conduit from box to designated electrical distribution system equipment and connection point. Connect complete.

.4 Confirm instruction labelling nomenclature with Consultant prior to manufacturer.

.5 Test installed assembly to satisfaction of Consultant. Confirm exact location with Consultant prior to roughing-in. Obtain required certificates of approvals and submit copy to Consultant.

3.5 INSTALLATION WORK ON EXISTING EQUIPMENT

.1 Coordinate manufacturers authorized technicians of existing equipment being retrofitted as part of work of this project. Perform work in accordance with respective equipment Manufacturer recommendations. Generally, perform work to allow existing genset to synchronize to and parallel with additional gensets and be operated by new control system that performs load sharing and load shedding. Modify and interconnect existing equipment to control system as noted on drawings.

.2 Demonstrate and test work to satisfaction of Consultant and Owner in conjunction with testing requirements specified herein this Section and in Section titled Electrical Work Testing.

END OF SECTION

Appendix: Engine-Generator Test Report

PROJECT: _____ EXP Job No: _____

_____ Date: _____

_____

OWNER: _____

ARCHITECT: _____

CONSULTING ENGINEERS: EXP Services Inc.

LOCATION: _____

_____

PRESENT: _____

_____

_____

ENGINE DATA: _____ SERIAL NUMBER: _____

_____

_____

UNIT - GENERAL

CONTROL PANEL - GENERAL

VIBRATION CONTROL

START-UP TIME

COLD UNIT: _____

HOT UNIT: _____

SAFETY DEVICES AND TIME DELAY OPERATION

SHUT-DOWN OPERATION	ALARM	BELL	LIGHT
LOW OIL PRESSURE			
HIGH COOLANT TEMP			
OVERSPEED			
OVERCRANK			
OTHERS			
SHUT-DOWN T/D	4 MIN. AFTER NORMAL POWER RESTORED		

HOUR METER READINGS

START:

CONCLUSION:

RECORDING INSTRUMENTS (SPEED OF CHART)

VOLTAGE (REGULATOR)

ALLOWABLE VARIATION:
ACTUAL VARIATION @ 0-1/4 LOAD =
ACTUAL VARIATION @ 0-1/2 LOAD =
ACTUAL VARIATION @ 0-3/4 LOAD =
ACTUAL VARIATION @ 0-1/1 LOAD =

FREQUENCY (GOVERNOR)

ALLOWABLE VARIATION:
ACTUAL VARIATION @ 0-1/4 LOAD =
ACTUAL VARIATION @ 0-1/2 LOAD =
ACTUAL VARIATION @ 0-3/4 LOAD =
ACTUAL VARIATION @ 0-1/1 LOAD =

RECOVERY TIME

VOLTAGE ADJUSTMENT (SPECIFY):

EXHAUST PRESSURE:

GENERAL OBSERVATIONS:

INCOMPLETE ITEMS AND/OR DEFICIENCIES:

METHOD OF LOADING (SPECIFY):

TIME IN MINUTES	
LOADING	
AMPS - PHASE 1	
AMPS - PHASE 2	
AMPS - PHASE 3	
VOLTS - PHASE 1	
VOLTS - PHASE 2	
VOLTS - PHASE 3	
FREQUENCY (HZ)	
OIL PRESSURE. (PSI)	
OIL TEMP (C°)	
WATER IN TEMP (C°)	
WATER OUT TEMP (C°)	
JACKET TEMP (C°)	
EXHAUST TEMP (C°)	
ENGINE SPEED (RPM)	
CHARGER	
POWER FACTOR	
GENERATOR TEMP (C°)	
ROOM TEMP (C°)	
EXHAUST SMOKE	
KW RATING	
VACUUM (GAS UNITS ONLY)	

EXP Services Inc.

Date: _____ Per: _____

END OF APPENDIX

Part 1 - General

1.1 SUBMITTALS

.1 Submit shop drawings for products specified in this Section, including but not limited to following:

- .1 genset enclosure;
- .2 enclosure accessories and components;
- .3 sub-base fuel tanks.

.2 Shop drawings to include following:

- .1 full design detail drawings;
- .2 layouts and dimensions;
- .3 equipment capacities;
- .4 wiring schematics;
- .5 integrated systems.

1.2 TYPICAL DETAILS

.1 Refer to typical details found on drawings for references to products and/or execution required in this Section.

1.3 WARRANTY

.1 Warrant (full parts and labour) entire genset enclosure and accessories, in writing, to be in strict accordance with Specification and free from defects for minimum one (1) year from date of site performance and acceptance test and subsequent written acceptance by Consultant.

.2 Above warranty requirements and issues to be provided by genset manufacturer or Manufacturer authorized genset supplier.

Part 2 - Products

2.1 GENSET ENCLOSURE (SKIN-TIGHT)

.1 "Skin-tight" type genset enclosure to be provided to house genset complete with silencers, control panel, batteries and accessories. General features include but are not limited to following:

- .1 outdoor, weatherproof, corrosion resistant;
- .2 sound attenuated;
- .3 non-combustible fire-rated construction designed to required local governing authority and code requirements;
- .4 heavy duty aluminium outer skin over heavy duty steel framework construction and primed and finished with corrosion resistant paint finish;
- .5 sound insulated panels;
- .6 exhaust silencer;
- .7 dry type distribution transformer and breaker panelboard, sized to accommodate loads of enclosure components requiring power feeds; factory prewired breaker panelboard to be 120/208 VAC with main breaker and branch breakers for feeding genset and enclosure components and accessories; include three (3) additional spare 15A-1P breakers installed in panel;
- .8 locking access panels;

.9 flexible coolant and lubricating oil drain lines, that extend to exterior of enclosure, with internal drain valves;

.10 external radiator fill provision;

.11 radiator guard;

.12 heavy duty steel beam mounting base;

.13 insulated ventilation louvers and dampers;

.14 insulated enclosure with non-hydroscopic materials;

.15 pitched roof;

.16 corrosion resistant stainless steel door hardware, hinges and locks;

.17 locking compartments for storage of manuals, spare parts and tools;

.18 warning signs;

.19 vandal proof construction;

.20 finish painted in colour as approved by Consultant;

.21 GFI receptacles inside enclosure, and a weatherproof GFI receptacle on outside of enclosure;

.22 switches controlling AC lamps mounted in vapour tight and gasketed fixtures;

.23 switched controlled vapour tight, gasketed DC light connected to main batteries, provide 60 minutes adjustable timer;

.24 external AC weatherproof and vandal proof HID type fixture with photocell control over panel access door;

.25 thermostatically controlled forced air internal heater to keep interior temperature at minimum temperature as per CSA C282;

.26 exhaust fan for internal high temperature heat removal from enclosure and include modulating thermostat control;

.27 emergency power off (EPO) station consisting of minimum 38 mm (1-1/2") diameter mushroom head, mounted in weatherproof enclosure with break glass cover for emergency access and locking operator for authorized access; typically mount recessed or semi-recessed in exterior wall of enclosure at each walk-in door; lock operator to be keyed to Owner requirements; provide "EMERGENCY POWER OFF" identification lettering; confirm exact nomenclature with Consultant prior to ordering;

.28 sub-base fuel tank;

.29 storage cabinet for O&M manuals and spare parts;

.30 seismic restraints as required by local governing building code.

.2 Enclosure to meet applicable codes and standards enforced by local governing authorities, including but not limited to:

.1 CSA C282;

.2 CSA Z32;

.3 ULC Standards;

.4 local applicable building codes;

.5 local applicable electrical codes;

.6 Ontario installation code for oil-burning equipment (Based on CSA B139, with Ontario amendments);

.7 Technical Standards and Safety Authority (TSSA).

.3 Enclosure assembly to be designed such that genset components needing routine maintenance and servicing are easily accessible from access doors. Access doors to be locking, hinged type with retainers to hold doors open during service.

.4 Intake and exhaust louvers to be located at height to minimize effects from flood waters and accumulated snow levels. No roof penetrations except for exhaust stack.

.5 Provide motorized intake louvers to minimize air flow through enclosure when generator set is not operating. Louvers to include provisions to prevent accumulation of ice or snow that might prevent operation. Louvers to be spring open, power close operation.

.6 Enclosures to include weatherproof cable stub and openings for connection cabling through underside of base. Provide load bank cabling entry and temporary genset connections via openings with flexible boots behind a gasketted locking hinged door. Boots to prevent egress of any precipitation into enclosure when cables are run into enclosure. Exterior components and parts to be corrosion resistant and weatherproof. Coordinate location of cable access openings to suit structural base. Provide cable connection box with copper bussing.

.7 Sound-attenuated housing rated to allow generator set to operate at full rated load in an ambient temperature of up to 40°C (104°F).

.8 **Acoustics:**

.1 Maximum permissible sound emissions criteria for enclosure at engine full load rating to be net 72 dBA at 7m (23') including provisions for reverberations from neighbouring walls.

.2 Selection of silencer (muffler) to be coordinated with design of enclosure to meet sound level requirements.

.3 Submit with shop drawings, certification letter from a recognized acoustical authority certifying factory testing acoustical performance of enclosure housed genset, with genset operating at full load rating in accordance with specification requirements.

.4 Include for a qualified acoustical engineer to perform an acoustical field test during onsite genset testing, to certify performance and provide documented test report. Measure noise levels at 10 different locations as coordinated by Consultant.

.5 Obtain and submit required approvals from local governing authorities having jurisdiction.

.6 Materials of construction to be to general accepted trade standards unless more stringent requirements are required by any recent codes or regulations by local governing authorities. Ensure that most recent applicable standards are met.

.9 Provide complete grounding and bonding conductor system in compliance with code requirements, complete with conductors from equipment and exterior ground rods or for connection to main building grounding system. Refer to Section titled Grounding and Bonding for additional grounding and bonding requirements.

.10 Provide an ULC S601 listed and labelled sub-base fuel tank. Installation to be in compliance with local governing authority regulations. Fuel tank to be double-walled, steel construction and include following features:

.1 enough fuel capacity to operate genset for a minimum ____ hours under full load nameplate rating;

.2 emergency tank and basin vents; vents to include vertical extension pipe to exterior of enclosure to meet local governing technical standards and safety authority standards;

.3 mechanical fuel level gauge;

.4 fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by engine manufacturer and in compliance with CSA, ULC and other applicable codes;

.5 leak detection provisions, wired to generator set control for local and remote alarm indication; provide fuel level leak detector inside void space of double wall tank and provide wiring and tie-in of fuel leak signal to genset control panel provide required relays for interconnection to leak detection system; system to include contacts as required for connection to main building automation system (BAS);

.6 high and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level;

.7 basin drain;

.8 integral lifting provisions;

.9 access to/in tank as per governing authority requirements.

.11 Engine exhaust system features are as follows:

.1 Engine exhaust system to be full factory installed within enclosure and consists of lengths of flexible stainless steel exhaust pipe, flange, and exhaust silencers. Size length of flexible piping for thermal expansion and engine vibration and to suit enclosure height restriction. Silencers to be based on Silex "Hospital Plus" series JDDPR type to provide highest degree of noise reduction and to suit respective size of genset and to be coordinated with enclosure design to suit spacing and overall noise criteria. Both flexible pipe and silencer to be suitable in all respects for application and be as recommended by genset supplier. Acceptable manufactures of silencers are Silex Inc., Vibron Ltd., Nelson, and Maxim.

.2 Custom manufacturer heavy duty steel exhaust flange to extend from silencer to roof thimble. Exhaust system exhausts out of enclosure roof through an insulated roof thimble designed for application and with weatherproof sealed pre-fabricated flashed roof curb. Thimble to be of heavy duty galvanized steel corrosion resistant construction.

.3 Terminate exhaust pipe flange minimum 450 mm (18") above roof line and top with required temporary weatherproof cap. Exhaust stack stub assembly to be capable of supporting an on-site installation of a vertical exhaust stack up to 10' (3m) high. Provide guy wires as required for proper support. Interior exhaust piping to be insulated with Rockwool type insulation suitable for application. Exact height of exhaust stack to suit MOE Certificate of Air and Noise Approval criteria coordinated with noise and emissions consultant and drawing requirements.

.4 Exhaust stack and piping to meet requirements of local governing technical standards and safety authority standards and other required governing authorities. Exterior vertical exhaust stack to be constructed of minimum schedule 40 rigid black steel, or double wall construction stainless steel chimneys as manufactured by Selkirk or Van-Packer. Diameter to suit genset sizing as noted and confirmed with genset manufacturer. Exhaust stack to extend to height confirmed with Consultant. Stack to be complete with provisions preventing ingress of water/snow. Stack in position to be designed to withstand anticipated wind forces and other forces of nature. Provide required supports and/or guy wiring as per stack manufacture's recommendations as coordinated with genset vendor.

.5 Coordinate routing, dimensions, and configuration of exhaust system with enclosure dimension restrictions and equipment layout as detailed and as noted.

.6 Ensure that exhaust stack is positioned in location such that emissions do not become drawn into enclosure during operation. Weatherproof and seal openings in roof due to exhaust stack work.

.7 Where required to suit exhaust configuration of respective gensets, provide properly sized black steel pipe welded "Y" connector.

.12 Lightning Protection

.13 **Fire alarm provisions:**

.1 Enclosure to include provisions of empty conduits with fish cord and boxes for installation of future detectors and associated fire alarm devices provided by main building fire alarm vendor. Coordinate work with fire alarm vendor.

.2 Provide fire extinguishers of CO2 type, minimum 10 pounds (4.5 kg), and mounted within enclosure. Exact type of fire extinguisher to be as recommended by genset vendor to suit application. Provide mounting bracket and install on interior wall adjacent door. Include identification label on outside of door identifying location of extinguisher.

.14 **Access and security signs:**

.1 Corrosion resistant, weatherproof and resistant to fading from sunshine.

.2 Red lettering on a white background.

.3 Permanently affixed.

.4 Nomenclature to be confirmed with Consultant prior to manufacturer.

.15 **Testing, Start-up, Verification and Training:**

.1 Perform standard factory testing as specified in Part 3 and submit copy of detailed reports to Consultant for review.

.2 Onsite after installation inspection, testing, start-up, and verification to be as specified in Part 3. Assist installing Contractor in installation of equipment and to inspect installation, test equipment, perform start-up and verify equipment. Coordinate work with Contractor.

.3 Be present to assist during third party testing.

.4 Perform testing at times coordinated with Consultant.

.5 Provide instructions on system operating and maintenance.

.16 Acceptable enclosure manufactures are as recommended by genset vendors/suppliers.

Part 3 - Execution

3.1 INSTALLATION

.1 Coordinate installation requirements with requirements of Section titled Power Generation.

.2 For on grade installations: Coordinate structural base requirements for mounting of containerized genset. Provide concrete pad as detailed on drawings. Include for seismic restraints as required.

.3 For roof installations: Coordinate structural mounting requirements with Structural Consultant. Coordinate roofing work with trades responsible for roofing. Provide required roof structural steel work to accommodate installation of containerized genset.

.4 Provide required vibration isolation and seismic restraints in accordance with Specification, Structural documents and as per local governing building code requirements.

.5 Provide shore power feeders in conduit from dedicated breakers in panelboards in building, serving container genset, and connect to integral power panel and devices as required. Connect feeders to panel and ensure that components and accessories that require external power are fed from panel breakers, as required. Identify breakers in panel. Refer to notes on drawings. Applicable distribution equipment to be provided to general standards of electrical products specified in other Sections. Exterior feeders in conduit to be RWU90 or TWU in rigid galvanized steel conduit, unless otherwise noted.

.6 Provide exhaust stack extension and mount to enclosure as per genset supplier's instructions. Secure as required. Provide lightning protection air terminal, down conductors and extend to grade ground rod driven into grade, as per code requirements.

.7 Connect and ground unit with proper copper ground conductors. Ground and bond equipment as per local electrical code requirements. Refer also to requirements of grounding and bonding article.

.8 Refer to and provide additional applicable testing requirements of distribution system testing and coordination study article.

.9 Coordinate fire alarm device installation work with main building fire alarm vendor. Extend fire alarm circuits from enclosure to main building and connect to local transponder/control panel designated by fire alarm vendor. Provide required low voltage relays, wiring in conduit and contactors from generator control panel to fire alarm system control panel for common supervision and annunciation of genset alarms. Coordinate with Mechanical Division BAS vendor to ensure that genset alarm points are connected to BAS as a common alarm. Extend control wiring of type suitable for specific applications and as recommended by vendor of system being connected to and terminate at panel designated by system vendor. Include for additional spare 3m (10') coiled length at end. Include for system vendor to make required connections to panel and required programming.

.10 Coordinate and arrange for main building security system vendor to provide security devices, wiring and connections. Extend circuits from common junction box in genset enclosure to main building and connect to main security system to annunciate as separate zones/points. Provide wiring and conduit of type to suit application in accordance with local governing codes and as recommended by system manufacturer.

.11 Provide concrete bollards and stairs as required. Coordinate concrete work, excavation and backfilling work with respective general trades.

.12 Test and verify functions of enclosure with genset testing.

.13 Obtain local governing technical standards and safety authority and other required local governing authority approvals and certifications.

.14 Additionally, refer to testing, coordination and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

.2 Section 26 05 29 - Hangers & Supports for Electrical Systems.

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA C22.2 No. 5, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).

.5 CSA C22.2 No. 178.1, Automatic Transfer Switches.

.6 CAN/CSA C60044-1, Instrument Transformers.

.7 CSA-C282 Emergency Electrical Power Supplies for Buildings

.8 NEMA ICS 2, Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.

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 transfer switches and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit manufacturer shop drawings.

.1 Indicate on drawings:

.1 Make, model and type.

.2 Single line diagram showing controls and relays.

.3 Description of equipment operation including:

.1 Automatic starting and transfer to standby unit and back to normal power.

.2 Test control.

.3 Manual control.

.4 Automatic shutdown.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data:

.1 Submit operation and maintenance data for transfer switches for incorporation into manual.

.2 Detailed instructions to permit effective operation, maintenance and repair.

.3 Technical data:

.1 Schematic diagram of components, controls and relays.

.2 Illustrated parts lists with parts catalogue numbers.

.3 Certified copy of factory test results.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect transfer switches from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 **SYSTEM DESCRIPTION**

.1 Automatic load transfer equipment to:

.1 Monitor voltage on phases of normal power supply.

.2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below pre-set adjustable limits for adjustable period of time.

.3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.

.4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.

.5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

2.2 **MATERIALS**

.1 Instrument transformers: to CAN/CSA C60044-1.

.2 Contactors: to NEMA ICS2.

2.3 **CONTACTOR TYPE BY-PASS ISOLATION TRANSFER EQUIPMENT**

.1 Contact Type Transfer Equipment: to CSA C22.2 No. 178.1., UL 1008

.2 Built-in by-pass to conserve room space.

.3 Two, 3-pole contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, motor solenoid operated, open type with CSA enclosure.

.4 Rated: 120/208V, 60 Hz, 4 wire. See electrical drawings for amperage.

.5 Main contacts: silver surfaced, protected by arc disruption means.

.6 Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance from front of panel without removal of switch panel or disconnection of drive linkages and power conductors.

.7 Auxiliary contact: silver alloy with gold flashings, to initiate emergency generator start-up on failure of normal power.

.8 Fault withstand rating: 42 kA symmetrical for 3 cycles with maximum peak value of 65 kA. See Electrical Drawings.

.9 Lever to operate switch manually when switch is isolated.

.10 Neutral bar, switch rated: See electrical drawings for Amperage.

.11 Overlapping neutral contacts on contactor type transfer equipment.

2.4 CIRCUIT BREAKER TYPE BY-PASS ISOLATION TRANSFER EQUIPMENT

.1 Circuit Breaker Type Transfer Equipment: to CSA C22.2 No. 5, No. 178 and No. 31.

.2 Built-in by-pass to conserve room space.

.3 Moulded Case Circuit Breakers to CSA C22.2, No. 5.

.4 Rated: 120/208V, 60Hz, 4 wire. See electrical drawings for amperage.

.1 Fault withstand rating: [25 kA symmetrical - see 2.4.4.11 below

.2 One normal, 3-pole moulded-case circuit breaker mounted on common base, designed for double throw action, motor operated, mechanically held and interlocked, floor mounted CSA enclosure.

.3 One emergency, 3-pole moulded-case circuit breaker with thermal magnetic trip, motor operated, and interlocked.

.4 Circuit breakers:

.1 Trip free in closed position.

.2 Interrupting rating: 25 kA.

.5 Dead front construction with access to relays and controls for inspection and maintenance, and manual operating lever for transfer switch.

.6 Auxiliary contact: to initiate emergency generator start-up on failure of normal power.

.7 100 % rated neutral bus line.

.8 Overlapping switchable neutral pole on circuit breaker type equipment.

.9 The transfer switch shall be 100% equipment rated for continuous duty.

.10 See Section 26 05 29 for Seismic Restraint Requirements.

.11 Transfer switches shall have a minimum symmetrical short circuit rating of 25 kA RMS based on protection from an upstream moulded case circuit breaker. Main contact assemblies shall have published extended withstand, closing and interrupting ratings for maximum system coordination, so that the transfer switch may be applied with an upstream protective device having a short time interrupting rating. Transfer switches having three-cycle only withstand ratings shall not be acceptable.

2.5 **CONTROLS - MICRO-PROCESSOR BASED OPEN-TRANSITION**

.1 Selector switch -4 position "Test", "Auto", "Manual", "Engine start".

.1 Test position - normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.

.2 Auto position - normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.

.3 Manual position - transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.

.4 Engine start position - engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.

.2 Control transformers: Manufacturer Standard to isolate control circuits from:

.1 Normal power supply.

.2 Emergency power supply.

.3 Microprocessor-Based Controller:

.1 The microprocessor-based controller shall be Manufacturer specific and shall provide the operator with an overview of the transfer switch status, parameters, and diagnostic data.

.2 Controller shall be manufacturer specific with the following. It shall be CSA approved and ULC listed.

.1 The microprocessor-based controller shall include an LCD display, and shall be capable of displaying the following:

.1 Connected Source and Load voltages on all phases

.2 Connected Source and Load frequency

.3 Condition status - Under-voltage, under-frequency, etc.

.4 Real time clock for Time / Date stamp

.5 Historical data

.6 Programming and set point information

.7 Timer countdown for each timer while functioning

.8 Help function for detailed description of displayed messages

.2 The microprocessor-based controller shall include individual LED's for indicating the following:

.1 Mimic Bus Diagram showing Availability status of NORMAL source

.2 Mimic Bus Diagram showing Availability status of EMERGENCY source

.3 Mimic Bus Diagram showing Connection status of NORMAL source

.4 Mimic Bus Diagram showing Connection status of EMERGENCY source

.5 Mimic Bus Diagram showing Preferred status of NORMAL source

.6 Mimic Bus Diagram showing Preferred status of EMERGENCY source

.7 Mimic Bus Diagram showing Energized status of LOAD

.8 Automatic mode

.9 Test mode

.10 Program mode

.11 Display Navigational indicators for Status, Source 1, Source 2, History, Time/Date and Set Points

.12 The microprocessor-based controller shall contain the following features:

.1 Programming protection

.2 Set points shall be stored in Non-Volatile memory, and use of an external battery source to maintain operation during "dead" periods shall not be required.

.3 Shall be capable of communicating to monitor all set points and operational characteristics over the following network protocol:

.1 RS232 INCOM

.2 10 Base T Ethernet

.3 RS485 Modbus RTU

.4 Historical Data Storage to include:

.1 Engine Run Time

.2 NORMAL source Available time

.3 EMERGENCY source Available time

.4 NORMAL source Connected time

.5 EMERGENCY source Connected time

.6 LOAD Energized Time

.7 Number of Transfers

.8 Date, Time and Reason for Last Sixteen (16) transfers

.5 The microprocessor-based controller shall contain the following voltage and frequency features:

.1 The voltage of each phase of the NORMAL source and the EMERGENCY source shall be monitored, with under-voltage dropout adjustable from 78% to 97% of nominal and pickup adjustable from dropout setting +2% to 99% of nominal.

.2 The voltage of each phase of the NORMAL source and the EMERGENCY source shall be monitored, with over-voltage dropout adjustable from 105% to 110% of nominal and pickup adjustable from dropout setting -2% to 103% of nominal.

.3 The frequency of the NORMAL source and the EMERGENCY source shall be monitored with under-frequency dropout adjustable from 90% to 97% of nominal and pickup adjustable from dropout setting +1 Hz to 99% of nominal.

.4 The frequency of the NORMAL source and the EMERGENCY source shall be monitored, with over-frequency dropout adjustable from 103% to 110% of nominal and pickup adjustable from dropout setting -1 Hz to 101% of nominal.

.6 The microprocessor-based controller shall contain the following time delay features:

.1 A time delay shall be provided on transfer to EMERGENCY source, adjustable from 0 to 1800 seconds. TDNE - Time Delay Normal to Emergency

.2 A time delay shall be provided to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds. TDES - Time Delay engine Start

.3 A time delay shall be provided on retransfer from EMERGENCY source to NORMAL source, adjustable from 0 to 1800 seconds. TDEN - Time Delay Emergency to Normal

.4 A time delay shall be provided after retransfer that allows the generator to run unloaded prior to shutdown, adjustable form 0 to 1800 seconds. TDEC - Time Delay Engine Cool down

.5 A time delay shall be provided for engine failure to start, fixed setting of 6 seconds. TDEF - Time Delay Engine Fail

.6 All delays shall be field adjustable from the microprocessor-based controller without the use of special tools.

.7 The microprocessor-based controller shall contain the following features:

.1 "HELP", "INCREASE", "DECREASE", "STEP" and "DISPLAY SELECT" pushbuttons

.2 Plant exerciser, selectable - 7-day interval, adjustable 0-600 minutes, load or no-load with Failsafe

.3 System Test Pushbutton

.4 A programmable Preferred Source Selector with LED light indication for "Utility to Utility" or "Utility to Generator" systems

.5 A programmable Preferred Source Selector with LED light indication for "Generator to Generator" systems. Provides dual engine starting circuits

.6 Alternative Transfer Mode of Operation Switch. Provide a 2-Position Selector Switch, maintained contact, marked: "AUTOMATIC" and "NON-AUTOMATIC". Transfer switch will be labeled as UL Non-Automatic

.7 Alternative Transfer Mode of Operation Switch. Selectable via programming and LED display marked: "AUTOMATIC" and "NON-AUTOMATIC" for full automatic operation or non-automatic retransfer operation with failsafe.

.8 Load Sequencing for up to ten (10) loads

.8 The microprocessor-based controller shall contain the following input/output contacts:

.1 One (1) Form C contact for closure of the Generator start circuit. The contacts shall be of silver alloy with gold flashing. The contacts shall be rated for 5-Amp at 250-VAC and 5-Amp at 30-VDC.

.2 One (1) Form C contact for PRE-TRANSFER SIGNAL. The contacts shall be rated for 10 Amp at 250 VAC and 10 Amp at 30 VDC.

.3 One (1) Form C contact for ALARM SIGNAL. The contacts shall be rated for 10Amp at 250 VAC and 10 Amp at 30 VDC.

.4 Surge Device to protect the controller.

2.6 **TRANSFER SWITCH OPERATION**

.1 The following Voltage and Frequency sensing shall be supplied:

.1 The voltage of each phase of the normal source shall be monitored, with dropout adjustable from 50% to 90% of nominal and pickup adjustable from dropout setting +2% to 100% of nominal

.2 The voltage of each phase of the emergency source shall be monitored, with dropout adjustable from 50% to 90% of nominal and pickup adjustable from dropout setting +2% to 100% of nominal

.3 The frequency of the emergency source shall be monitored, with dropout adjustable from 90% to 100% of nominal and pickup adjustable from dropout setting +1 Hz to 110% of nominal.

.4 Voltage measurement accuracy shall be +/-2% of nominal input voltage and frequency measurement accuracy shall be +/-0.1 Hz.

.2 The following Time Delay features shall be supplied:

.1 A time delay shall be provided to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.

.2 A time delay shall be provided on transfer to emergency, adjustable from 0 to 30 minutes.

.3 A time delay shall be provided on retransfer from emergency to normal, adjustable from 0 to 30 minutes. This time delay shall be bypassed if emergency source fails and normal source is available.

.4 A time delay shall be provided after retransfer that allows the generator to run unloaded prior to shutdown, adjustable from 0 to 30 minutes.

.5 All delays shall be field adjustable from the microprocessor-based controller without the use of special tools.

2.7 ACCESSORIES

.1 Ensure pilot lights indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel door.

.2 Plant exerciser: 168 hours timer to start standby unit once each week for selected interval but does not transfer load from normal supply transfers load to emergency supply and retransfers to normal supply on standby unit shutdown. Timer adjustable 0-168 hours in 15 minute intervals.

.3 Auxiliary relay to provide 4 N.O. and 4 N.C. contacts for remote alarms.

.4 Instruments:

.1 Digital true RMS, indicating type 2% accuracy, flush panel mounting:

.1 Voltmeter

.2 Ammeter

.3 Frequency meter: scale 55 to 65 Hz.

.5 Manual bypass and isolator: to emergency supply only.

2.8 EQUIPMENT IDENTIFICATION

.1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Control panel:

.1 For selector switch and manual switch: size 4 nameplates.

.2 For meters, indicating lights, minor controls: use size 2 nameplates.

2.9 SOURCE QUALITY CONTROL

.1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested.

.2 Manufacturer standard tests with the following as a minimum:

.1 Operate equipment both mechanically and electrically to ensure proper performance.

.2 Check selector switch, in modes of operation Test, Auto, Manual, Engine Start and record results.

.3 Check voltage sensing and time delay relay settings.

.4 Check:

.1 Automatic starting and transfer of load on failure of normal power.

.2 Retransfer of load when normal power supply resumed.

.3 Automatic shutdown.

.4 In-phase monitor operation.

2.10 **MANUFACTURERS**

.1 Acceptable Products:

.1 Eaton Yale Company

.2 ASCO Power Systems Canada

.3 Russelectric

Part 3 - Execution

3.1 **INSTALLATION**

.1 Locate, install and connect transfer equipment as indicated.

.2 Check relays solid state monitors and adjust as required to ensure correct operation.

.3 Install and connect battery and remote alarms.

3.2 **FIELD QUALITY CONTROL**

.1 Manufacturer recommended field tests with the following as a minimum:

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Energize transfer equipment from normal power supply.

.3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.

.4 Set selector switch in "Manual" position and check to ensure proper performance.

.5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.

.6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.

.7 Repeat, at 1 hour intervals, 2 times, complete test with selector switch in each position, for each test.

3.3 **CLEANING**

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 - General

1.1 SCOPE

.1 The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers. Refer to related sections for surge requirements in:

1.2 RELATED SECTIONS

.1 Section 26 05 00 - Common Work Results for Electrical

.2 Section 26 24 13 - Distribution Switchboards

.3 Section 26 24 16.01 - Panelboards Breaker Type

1.3 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449).

1.4 SUBMITTALS - FOR REVIEW/APPROVAL

.1 The following information shall be submitted to the Engineer:

.1 Provide verification that the SPD complies with the required ANSI/UL 1449 latest Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).

.2 For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

.2 Where applicable the following additional information shall be submitted to the engineer:

.1 Descriptive bulletins

.2 Product sheets

1.5 SUBMITTALS - FOR CONSTRUCTION

.1 The following information shall be submitted for record purposes:

.1 Final as-built drawings and information for items listed in Section 1.4 and shall incorporate all changes made during the manufacturing process

.2 Manufacturer's verification report

1.6 **QUALIFICATIONS**

.1 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

.2 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

.3 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years.

.4 The SPD shall be compliant with the latest issuance of the Restriction of Hazardous Substances (RoHS) Directive.

1.7 **DELIVERY, STORAGE AND HANDLING**

.1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.8 **OPERATION AND MAINTENANCE MANUALS**

.1 Operation and maintenance manuals shall be provided with each SPD shipped.

Part 2 - Products

2.1 **MANUFACTURERS**

.1 Eaton Yale Company

.2 Erico (Critec) International

.3 Schneider Electric Canada

.4 Innosys Power Inc.

.5 The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 **VOLTAGE SURGE SUPPRESSION - GENERAL**

.1 Electrical Requirements

.1 Unit Operating Voltage - Refer to drawings for operating voltage and unit configuration.

.2 Maximum Continuous Operating Voltage (MCOV) - The MCOV shall not be less than 115% of the nominal system operating voltage.

.3 The suppression system shall incorporate thermally or fuse protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

.4 Protection Modes - The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	**L-N**	**L-G**	**L-L**	**N-G**
Wye	•	•	•	•
Delta	N/A	•	•	N/A
Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

.5 Nominal Discharge Current (I_n) - All SPDs applied to the distribution system shall have a minimum 20 kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20 kA shall be rejected.

.6 ANSI/UL 1449 Latest Edition Voltage Protection Rating (VPR) - The maximum ANSI/UL 1449 Latest Edition VPR for the device shall not exceed the following:

Modes	**208Y/120**	**480Y/277**	**600Y/347**
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

.2 SPD Design

.1 Maintenance Free Design - The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

.2 Balanced Suppression Platform - The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

.3 Electrical Noise Filter - Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable to meet this specification shall not be accepted.

.4 Internal Connections - No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

.5 Monitoring Diagnostics - Each SPD shall provide the following integral monitoring options:

.1 Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.

.1 For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

.2 For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

.3 The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

.2 Remote Status Monitor - The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

.3 Audible Alarm and Silence Button - The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

.4 Surge Counter - The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

.1 The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

.6 Overcurrent Protection

.1 The unit shall contain thermally or fuse protected MOVs. Thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

.7 Fully Integrated Component Design - All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

.8 Safety Requirements

.1 The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

.2 SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

.3 Sidemount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Sidemount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.3 SYSTEM APPLICATION

.1 The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

.2 Surge Current Capacity - The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	**Application**	**Per Phase**	**Per Mode**
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

.3 SPD Type - all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.4 SERVICE ENTRANCE PROTECTION

.1 The SPD for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL1283 and UL 1449 Fourth Ed. Type 1 for use in Type 1 or Type 2 locations. All SPD units shall be RoHS compliant.

.2 Exposure Level: High

.3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B/C and C-High bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-2002 Measured Limiting Voltage					
B/C Impulse (6 kV, 3 kA)					
Voltage (Voltage Code)	L-N	L-G	L-L	N-G	
120/208 (3Y208)	725V	726V	1098V	728V	
347/600 (3Y600)		1090V	1144V	2017V	1155V
600 Delta (600NN)			2095	2098	
C-High Impulse (20 kV, 10 kA)					
Voltage (Voltage Code)	L-N	L-G	L-L	N-G	
120/208 (3Y208)	1030V	1420V	1300V	1225V	
347/600 (3Y600)		1537V	1707V	2470V	1800V
600 delta (600NN)		2420V	2203V		
UL Voltage Protection Ratings					
Voltage (Voltage Code)	L-N	L-G	L-L	N-G	
120/208 (3Y208)	800V	800V	1200V	800V	
347/600 (3Y6000)	1500V	1500V	2500V	1500V	
480 delta (600NN)		2500V	2500V		

.4 The unit shall have a peak surge current of no less than [select one: 400 kA/phase, 200 kA/mode; 300 kA/phase, 150 kA/mode; 240 kA/phase, 120 kA/mode], 8 X 20 us waveform, single impulse, independently verified.

.5 Where Internal Fusing is used for Overcurrent Protection

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.

.2 Fusing shall be present in every mode, including Neutral-to-Ground.

.3 The fusing shall be capable of interrupting up to a 200 kA symmetrical fault current with 600 VAC applied.

.6 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a NEMA 4 steel enclosure.

.7 SPD's for service entrance locations shall have a transient event counter with LCD panel display and reset button on the front cover.

2.5 DISTRIBUTION PANEL AND MOTOR CONTROL CENTER PROTECTION

.1 SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL 60384-14 (formerly UL 1283), and UL1449 Fourth Ed. Type 1 or 2 for use in Type 1 and Type 2 locations. All SPD units shall be RoHS compliant. Integral SPD shall not be acceptable.

.2 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B/C and C-High bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-2002 Measured Limiting Voltage				
B3/C1 Impulse (6 kV, 3 kA)				
Voltage (Voltage Code)	**L-N**	**L-G**	**L-L**	**N-G**
120/208 (3Y208)	651V	640V	1041V	646V
347/600 (3Y600)	1295V	1295V	2130V	1292V
600 Delta (600NN)		2202V	2217V	
C3 Impulse (20 kV, 10 kA)				
Voltage (Voltage Code)	**L-N**	**L-G**	**L-L**	**N-G**
120/208 (3Y208)	960V	1010V	1310V	860V
347/600 (3Y600)	1710V	1783V	2893V	1610V
600 Delta (600NN)		2760V	2340V	
UL Voltage Protection Ratings				
Voltage (Voltage Code)	**L-N**	**L-G**	**L-L**	**N-G**
120/208 (3Y208)	700V	700V	1200V	700V
347/600 (3Y600)	1500V	1500V	2500V	1500V
600 Delta (600NN)		2500V	2500V	

.3 The unit shall have a peak surge current of no less than 160 kA/phase, 80 kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

.4 Where Internal Fusing is used for Overcurrent Protection

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more then one MOV per mode.

.2 Fusing shall be present in every mode, including Neutral-to-Ground.

.3 The fusing shall be capable of interrupting up to a 200 kA symmetrical fault current with 600 VAC applied.

.5 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a NEMA 4 steel enclosure.

2.6 **SUBPANEL AND LIGHTING PANEL PROTECTION**

.1 SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL 60384-14 (formerly UL1283), and UL1449 Fourth Ed. Type 1 or 2 for use in Type 1 and Type 2 locations. All SPD units shall be RoHS compliant. Integral SPD shall not be acceptable.

.2 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 1991, categories A1 & A3 ring wave, 180 degree phase angle, category B3 Ringwave, and UL suppressed voltage ratings, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage				
A1 Ring Wave (2 kV, 67 A)	**Tested at 180 degree phase angle**			
Voltage (Voltage Code)	**L-N**	**L-G**	**L-L**	**N-G**
120/240 (1S240)	29V	46V	39V	40V
120/208 (3Y208)	29V	46V	39V	40V
347/600 (3Y600)	56V	99V	76V	88V
A3 Ring Wave (6 kV, 200 A)	**Tested at 180 degree phase angle**			
Voltage (Voltage Code)	**L-N**	**L-G**	**L-L**	**N-G**
120/240 (1S240)	56V	81V	88V	112V
120/208 (3Y208)	56V	81V	88V	112V
B3 Ring Wave (6 kV, 500 A)	**Tested at 90 degree phase angle**			
Voltage (Voltage Code)	**L-N**	**L-G**	**L-L**	**N-G**
120/240 (1S240)	437V	592V	612V	324V
120/208 (3Y208)	437V	592V	612V	324V
UL Voltage Protection Ratings				
Voltage (Voltage Code)	**L-N**	**L-G**	**L-L**	**N-G**
120/240 (1S240)	700V	700V	1000V	700V
120/208 (3Y208)	700V	700V	1000V	700V
347/600 (3Y600)	1500V	1500V	2500V	1500V

.3 The unit shall have a peak surge current of no less than 120 kA/phase, 60 kA/mode, 8 X 20 µs waveform, single impulse, verified by third party test reports.

.4 Where Internal Fusing is used for Overcurrent Protection

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more then one MOV per mode.

.2 Fusing shall be present in every mode, including Neutral-to-Ground.

.3 The fusing shall be capable of interrupting up to a 200 kA symmetrical fault current with 600 VAC applied.

.5 The SPD shall be capable of attenuating internally generated ringing type transients and noise, and shall have an enhanced transient filter supported by a specification sheet which lists the IEEE A1 Ring Wave let-through levels no higher than those set forth above.

.6 Because of space limitation, the enclosure shall not exceed 4.0" D x 4.0" W x 10.3" H to allow close-to-the load installation on flush mount panels and between adjacent panelboard. For recessed panels, a flush mount cover plate shall be provided with each unit.

.7 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a NEMA 1 steel enclosure.

2.7 **CONTROL PANELS AND INDIVIDUAL EQUIPMENT**

.1 SPD(s) for this location shall be as indicated on project drawings.

.2 Incoming three phase power to control panels and disconnects feeding select individual pieces of equipment shall be protected.

.3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B/C and C-High bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-2002 Measured Limiting Voltage		
B/C Impulse (6 kV, 3 kA)		
Voltage (Voltage Code)	**L-G**	**L-L**
480 (480NN)	1423	1481
600 (600NN)	1907V	1927V
C-High Impulse (20 kV, 10 kA)		
Voltage (Voltage Code)	**L-G**	**L-L**
480 (480NN)	1870V	1950V
600 (600NN)	2420V	2410V
UL 3rd. Ed. V.P.R.		
Voltage (Voltage Code)	**L-G**	**L-L**
480 (480NN)	1800V	1800V
600 (600NN)	2500V	2500V

.4 The unit shall have a peak surge current of no less than 120 kA/phase, 60 kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

.5 Where Internal Fusing is used for Overcurrent Protection

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more then one MOV per mode.

.2 Fusing shall be present in every mode, including Neutral-to-Ground.

.3 The fusing shall be capable of interrupting up to a 200 kA symmetrical fault current with 600 VAC applied.

.6 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a NEMA 4 steel enclosure.

2.8 **CONTROL VOLTAGE CIRCUITS**

.1 The SPD for this location shall be as indicated on project drawings.

.2 The manufacturer shall provide written specifications showing let-through voltage of the unit pursuant to ANSI/IEEE C62.41 and C62.45, 1991, categories A1 and A3 ringwave and category B3/C1 impulse, 90 or 180 degree phase angle as listed below, positive polarity, dynamic or static test, which shall be no higher than:

Al (2 kV, 67 A) (180 degrees)	**A3 (6 kV, 200 A) (90 degrees)**	**B3/Cl (6 kV, 3 kA) (90 degrees)**
L-N 28	L-N 108	L-N 444
L-G 28	L-G 104	L-G 440
N-G 28	N-G 100	N-G 456

.3 The unit shall have an indicator light monitoring the status of the unit.

.4 For safety and performance the suppressor shall have a fail-safe design with dual component-level fusing (short circuit fusing plus thermal fusing).

.5 The unit shall have a peak surge current of no less than 40 kA/phase, 8 X 20 us waveform, single impulse.

.6 The unit shall be an ETL recognized component under UL 1449 Fourth Edition as a type 4 SPD, and also under UL 1283.

.7 The unit shall be mounted in line on a 120 volt circuit and must be capable of carrying a continuous 30 amp load.

.8 For strength and fire retardant properties, the unit shall be housed in an ABS UL94-5VA rated enclosure.

2.9 **SUBPANELS FEEDING FIRE ALARM, SECURITY, MEDICAL/CRITICAL LOAD PANELS**

.1 SPD(s) for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL 60384-14 (formerly UL1283), and UL1449 Fourth Ed. Type 1 or 2 for use in Type 1 and Type 2 locations. All SPD units shall be RoHS compliant.

.2 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories A1 & A3 ring wave, 180 degree phase angle, category B3 Ringwave, and UL suppressed voltage ratings, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage				
A1 Ring Wave (2 kV, 67 A)	**Tested at 180 degree phase angle**			
Voltage (Voltage Code)	**L-N**	**L-G**	**L-L**	**N-G**
120/240 (1S240)	29V	46V	39V	40V
120/208 (3Y208)	29V	46V	39V	40V
A3 Ring Wave (6 kV, 200 A)	**Tested at 180 degree phase angle**			

Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/240 (1S240)	56V	61V	88V	112V
120/208 (3Y208)	56V	61V	88V	112V
B3 Ring Wave (6 kV, 500 A)	**Tested at 90 degree phase angle**			
Voltage (Voltage Code)	**L-N**	**L-G**	**L-L**	**N-G**
120/240 (1S240)	437V	592V	612V	324V
120/208 (3Y208)	437V	592V	612V	324V

.3 The unit shall have a peak surge current of no less than 120 kA/phase, 60 kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

.4 Each MOV shall have component level overcurrent fusing allowing for direct bus connection or installation on any size breaker or non-fused disconnect. Component level fusing will pass unit's full rated peak surge current without premature fuse failure that occurs with cartridge type power fuses.

.5 The SPD for subpanel protection shall be capable of attenuating internally generated ringing type transients and noise, and shall have an enhanced transient filter supported by a specification sheet which lists the IEEE A1 Ring Wave let-through levels no higher than those set forth above.

.6 Because of space limitation, the enclosure shall not exceed 4.0" D x 4.0" W x 10.3" H to allow close-to-the load installation on flush mount panels and between adjacent panelboard. All units shall come with a flush mount cover plate.

.7 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability and shall have at minimum a NEMA 1 steel enclosure.

2.10 **DATA & SIGNAL LINE PROTECTION**

.1 The data line shall be protected with 4-20 mA surge suppressors.

.2 The unit shall have a data transmission rate up to 10.0 Mbps.

.3 Each conductor shall have less than 2.4 ohm of internal series resistance per wire, and each pair of conductors shall have a peak surge current of no less than 9,000 amps per wire (18,000 amps per pair), 8 x 20 us waveform.

.4 The maximum let-through voltage on an ANSI/IEEE C3 Impulse (20 kV/10 kA) shall be 41 volts line to line, 41 volts line to ground, and 41 volts shield to ground. The maximum let-through voltage on an IEC 10 x 700 us impulse (2 kV/80 A) shall be 38 volts line to line, 38 volts line to ground, and 38 volts shield to ground.

.5 The response time of the components of the unit shall be less than one nanosecond.

.6 For quality assurance, manufacturer must provide proof that manufacturer has been regularly engaged in the design, manufacturing and testing of SPD's of the types and ratings required for a period of not less than five years.

2.11 **ENCLOSURES**

.1 All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:

.1 NEMA 1 - Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).

.2 NEMA 4 - Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (sidemount units only)

.3 NEMA 4X - Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (sidemount units only)

Part 3 - Execution

3.1 **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 and UL standards.

3.2 **INSTALLATION**

.1 The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

.2 Include for manufacturer's technician to visit site and verify the installation. Provide a verification certificate confirming proper installation of each SPD.

3.3 **WARRANTY**

.1 The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code. Warranty shall include replacement of the unit if destroyed by lightning or other transients during the warranty period.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Division 09 - Painting & Coatings

.2 Section 26 05 00 - Common Work Results for Electrical

.3 Section 26 05 19 - Building Wire and Cable

.4 Section 26 05 33 - Conduit

.5 Section 26 05 35 - Surface Raceways

.6 Section 26 09 24 - Lighting Control Devices

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 ANSI C82.1, Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.

.5 ANSI C82.4, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps Multi Supply Type.

.6 ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

.7 ASTM F1137, Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.

.8 Canadian Standards Association (CSA International)

.9 ICES-005, Radio Frequency Lighting Devices.

.10 Underwriters Laboratories of Canada (ULC)

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, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Consultant.

.3 Samples: Provide samples if indicated on drawings or requested by the Owner during construction.

.4 Quality Assurance Submittals: provide in accordance with Section 01 45 00 - Quality Control

.1 Manufacturers instructions: provide manufacture's written installation instructions and spec handling criteria, installation sequence, cleaning procedures.

.5 Shop Drawings:

.1 Shop drawings shall be supplied for all lighting fixtures supplied under this Contract.

.2 Shop drawings shall include lamp specifications provided by an approved lamp manufacturer.

.3 Shop drawings for LED luminaires shall include project specific wiring diagrams detailing the required circuitry from the luminaire to the driver/power supply and from the driver/power supply to the lighting control device (i.e. room light switch, relay circuit or dimming control circuit)

1.4 QUALITY ASSURANCE

.1 Provide mock-ups if indicated on drawings or requested by the Owner during construction, in accordance with Section 01 45 00 - Quality Control.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Divert unused metal materials from landfill to metal recycling facility.

1.6 FIXTURE CATALOGUE REFERENCES

.1 The fixture catalogue numbers listed do not include all required accessories to provide a complete installation of the fixtures as intended or as described.

.2 The description of each fixture should be carefully read prior to quoting and the Tender price shall include all such necessary accessories and characteristics.

.3 No extras will be allowed for the Supplier or Contractor failing to provide such accessories.

1.7 ACCEPTABLE PRODUCTS

.1 Acceptable products are listed in the Lighting Fixture Schedule as "Design Products" (i.e. Products on which the lighting design was developed).

.2 Other products will also be accepted provided they are; Equal in aesthetic (i.e. share the same geometric form) are of the same material, manufactured to the same level of quality, provide equal or better performance in terms of illumination and energy consumption and that are offered with the same accessories and finish options as specified for the Design Products.

.3 The Client and Consultant Team reserve the right to request alternatives for any product submittals that do not share the same qualities, as noted above, as those of the Design Products listed in the Lighting Fixture Schedule.

.4 Exception will not be given for substitutes offered due to long lead times associated with product delivery.

Part 2 - Products

2.1 **LIGHT EMITTING DIODE (LED) SYSTEMS**

.1 LED luminaires shall provide a continuous and controllable light source. Lamp output and dimensions shall be in accordance with contract drawings and specifications. LED luminaire lumen output will be in accordance with the specifications and shall not depreciate more than 20% after 10,000 hours of use. Rated lumen output for LED luminaires to operate in ambient temperature of -4°F (20°C) -20°C to 122°F (50°C) +50°C. Luminaires to have minimum life of 50,000 hours.

.2 LED Luminaires of any particular Fixture Type as called for in the Lighting Fixture Schedule shall provide constant color quality across the luminous surface of the luminaire and/or surface being illuminated throughout the entire warranty period. Products that demonstrate a noticeable shift in either color fidelity or chromaticity are not acceptable and shall be replaced at the expense of the luminaire manufacturer.

.3 All LEDs used in the LED luminaires will be of high brightness and proven quality. All LEDs shall be driven digitally with pulse width modulation control to prolong life and maintain consistency of lumen output.

.4 All connections to luminaires will be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

.5 Fuse Protections: All power supply outputs will be either fuse protected or PTC-protected as per Class 2 UL listing. All luminaires will have built-in fuse protection. All power supplies will provide for knockouts for conduit connections or clamp-style connection for the low-voltage wiring.

.6 **Remote Mounted LED Drivers & Power Supplies:**

.1 LED drivers and power supplies shall be compatible with the LED(s) installed in the fixture. All LED luminaires, remote drivers and power supplies shall be furnished by a single manufacturer to insure compatibility.

.2 Electric Characteristics (at 77°F (25°C) ambient temperature):

.3 Input Voltage Range - 108V to 132V

.4 Efficiency: Minimum 80%

.5 Output Current Regulation Range (+/-) 5%A

.6 Total Harmonic Distortion (THD): 20% maximum

.7 Power Factor: 0.9 minimum

.8 Crest Factor (LED Current): 1.5 maximum

.9 FCC Class B for Conducted EMI

.10 FCC Class A for Radiated EMI

.11 Rated Life: 50,000 hours minimum

.7 **LED Lamps:**

.1 All LED lamps of a given shape and size shall be of the same manufacturer.

.2 Acceptable Manufacturers include those listed in the Lighting Fixture Schedule.

.3 Alternate Manufacturers will be considered based on:

.1 Dimming Compatibility

.2 A written declaration of compatibility shall be obtained from the control system and/or device manufacturer(s) and submitted to the consultant.

.3 Performance

.4 Alternate Manufacturers are subject to the acceptance criteria outlined in Part 1.

.4 Average rated life of 25,000 hours minimum.

.5 Lamps shall be rated for use in fully enclosed fixtures where installation requires this rating.

.6 Lamps shall be rated for use in wet location where installation requires this rating.

.7 Lamps shall include shatterproof rating in applications where lamps are located over food preparation areas.

2.2 GENERAL LIGHTING FIXTURE REQUIREMENTS

.1 Quality: Install only lighting fixtures which are structurally well designed and constructed and which use new parts and materials of highest commercial grade available.

.2 Matching ballasts and LED drivers/power supplies to control devices: Ballasts, LED drivers/power supplies, shall be compatible for use with the lighting control devices specified under Section 26 09 24.

.3 Matching Lamps and Ballasts: Lamps and ballasts shall be of the same manufacturer for any given luminaire used on this project.

.4 Matching Ceiling and Fixture Finishes: Before ordering fixtures verify the finish of exposed ceiling support members & metal tiles and paint to match ceiling colour. For recessed fixtures, trim finishes shall be selected during shop drawing review.

.5 Manufacturer's Operational Tests:

.1 Test fixture for acceptance of lamp made to maximum tolerance as required in A.N.A. Standards as listed in Section 26.

.2 Test fixtures with rated lamps for starting and operation.

.3 Check wiring for agreement with design circuit.

.4 Test for short circuits and improper grounds.

.6 Commercially Listed Fixtures: Lighting fixtures shall be of the types, sizes, ratings, etc. shown in the Fixture Schedule and notes therein or as shown on Drawings.

2.3 DELIVERY

.1 Assemble completely all fixtures at the Manufacturer's plant and deliver to the project site in original cartons. Ensure that a dry and protected space is available for proper storage before delivery of production fixtures.

2.4 HANGERS & FITTINGS

.1 **General:**

.1 Support fixtures as shown on the drawings, level, plumb and true with the structure and other equipment, and in a horizontal or vertical position as intended.

.2 Surface mounted fixture 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.

.2 **Supports:**

.1 Self-alignment ball joint hangers shall be used for rod suspended fixtures, and ceiling canopies shall be fitted tightly to the ceiling without restricting the alignment of the hanger.

.2 Support fixtures by hangers and mounting arrangements which will not cause the fixture frame, housing, sides or lens frame to be distorted; or prevent complete alignment of several fixtures in a row.

.3 Mounting methods for fixtures on or in suspended ceilings are to be as follows:

.1 Where lighting fixtures are surface mounted on suspended ceilings or are mounted below suspended ceilings, or recessed into suspended ceilings, these fixtures are to be supported independently of the ceiling using #12 jack chain hangers. Each chain is to be secured separately to the structure above so that no weight falls on the ceiling suspension system.

.2 Secure surface mounted equipment with twist clip fasteners to inverted tee bar ceilings and independently support clips using jack chain to structure above.

.3 In no case will reinforcement of the ceiling suspension system be considered to be adequate support for the lighting fixtures.

.4 Where cross member supports are required above the ceiling to provide support points, these are to be steel channels or angles.

.5 Toggle bolts of the snap-on or spring-in type are not to be used through drywall, tile and similar type ceilings.

.3 **Suspension Length:**

.1 The suspension length for all suspended types of lighting fixtures, as listed in the Fixture Schedule, shall be the overall length from the underside of the ceiling to the highest point of the fixture body, reflector, or glassware in its hanging position.

.2 The length of the stems or chain hangers of suspended fluorescent lighting fixtures shall be adjusted to hang all fixture bodies in the same room level and in the same horizontal plane, unless specifically required to be otherwise on the electrical drawings.

.4 **Chain Hangers:**

.1 Where fixtures are specified to be chain hung, the chain used shall be No. 4 Tensile bright zinc coated with a strength of 181 kg. Attachments shall be made using No. 105 "S" hooks. Wires running down chain to fixture shall be run in flexible conduit and shall be attached to chain with "Plasklip" cable clips.

2.5 **FIXTURE CONSTRUCTION**

.1 All interior fixtures shall comply with CSA Standard C22.2 No. 9, latest edition, complete with accessories and components, complying with relevant CSA standards applicable to accessory or component.

.2 All fixtures shall be CSA approved and/or approved by the Inspection Department of Ontario Hydro.

.3 All fixture types shall be designed with adequate heat sinks to dissipate the generated heat in order to prevent ballast and lamps from overheating with the resulting decrease in their rated life expectancy and/or light output.

.4 Fixtures shall be designed so that minimal task is required for LED's and LED Driver and/or Power Supply replacement.

.5 Provide proper trim for each luminaire as required for various types of ceiling being installed throughout the project; plaster rings, luminaire ends or caps, suspension units, mounting brackets and/or other accessory parts necessary for a complete luminaire.

.6 Gasketting material shall be vinyl or other non-aging type material as approved by the Consultant.

2.6 **LIGHT FIXTURES**

.1 Provide products listed in the Lighting Fixture Schedule shown on the Lighting Drawings.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Installation of all lighting equipment shall comply with the relevant Sections of this Specification, the Ontario Electrical Safety Code .

.2 Recessed or semi-recessed fixture shall be wired with BX90 or R90 wire in flexible steel conduit to adjacent outlet boxes placed above the finished ceiling, within reach of the fixture holes. Check the ceiling construction prior to ordering the fixtures to ensure that the fixture mounting is suitable and acceptable to the Engineer.

.3 Recessed or semi-recessed fixtures in dropped ceilings, shall be supported by chain hangers fastened securely to the structural ceiling; not supported by the tees of the dropped ceiling.

.4 Plaster frames and rings shall be provided for fixtures recessed in plaster ceilings under this Section. The installation of plaster rings shall be done by others (Division 09) under the supervision of Division 26. Contractor to ensure that they are located correctly. All costs for installation by Division 26.

.5 All outlet boxes for ceiling-mounted light fixtures are to be flush mounted unless otherwise noted. Where outlet boxes for lighting fixtures are specified to be surface mounted in finished areas on precast ceilings, use deep canopies to cover outlet box. In finished areas, canopies are to be neatly notched to provide for entry of wiring.

.6 At the completion of construction and acceptance of work, all lighting fixtures shall be clean, complete with all necessary accessories and provided with the required operating lamp(s).

.7 Fixtures shown on continuous rows or broken lines shall be carefully aligned so that all rows appear as straight lines. Crooked lines or misplaced fixtures will not be accepted and such poor workmanship shall be corrected.

.8 Fixtures as shown on the electrical drawings are approximate locations only. Installation of fixtures shall be in accordance with reflected ceiling plans, details and/or field instructions issued by the Architect.

.9 Lighting fixtures in service areas, and Mechanical and Electrical Rooms shall be installed after the mechanical and electrical equipment is in place. The fixtures shall be located on site to clear all obstructions and suspended on chain hangers. Rigid mount in air plenum rooms to the approval of the Engineer.

.10 Check the latest ceiling finishes in all areas where recessed fixtures are being installed to ensure that the fixtures which are ordered for these areas are purchased with suitable ceiling trim for the particular ceiling finish. Fixtures which are sent to the site with wrong ceiling trim or flanges shall be replaced with fixtures having the correct trims, without additional cost.

.11 When LED replacement lamps are called for, supply and turn over to Owner one (1) additional case (minimum 20 lamps per case) of each lamp type used on the project.

3.2 **WIRING**

.1 Refer to Sections 26 05 19 and 26 05 33.

3.3 **CLEANING**

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

.2 Section 26 08 00 - Electrical Systems Commissioning.

.3 Section 26 05 33 - Conduit

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA C22.2 No. 141, Emergency Lighting Equipment.

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 specified products and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for specified products for incorporation into manual.

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 accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect products from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

1.6 WARRANTY

.1 Battery: 3 years (prorated)

.2 Charger: 3 years

Part 2 - Products

2.1 **EQUIPMENT**

.1 Emergency lighting equipment: to CSA C22.2 No. 141.

.2 Supply voltage: 120 VAC.

.3 Output voltage: 12 VDC, unless indicated otherwise on Drawings.

.4 Operating time: 120 minutes in Main Electrical Room or ATS Room; 30 minutes in all other applications.

.5 Battery: sealed, maintenance free.

.6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.

.7 Solid state transfer circuit.

.8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

.9 Signal lights: solid state, for 'AC Power ON'.

.10 Lamp heads: remote, weather-proof 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: 15 Watt MR16LED, 1320 lumens in Main Electrical Room or ATS Room; 6 Watt MR16LED, 527 lumens in all other applications.

.11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.12 Finish: white.

.13 Auxiliary equipment:

.1 Push-to-Test switch and, in Main Electrical Room or ATS Room, automatic self-diagnostics, which shall run for 1 minute each month, 10 minutes on the 6th month (annually) and 30 minutes on the 12th month (annually).

.2 Battery disconnect device.

.3 AC input and DC output terminal blocks inside cabinet.

.4 Shelf or bracket, as required.

2.2 **WIRING OF REMOTE HEADS**

.1 Conduit: in accordance with Section 26 05 33 - Conduit.

.2 Conductors: RW90, #10 AWG minimum for each circuit and run in conduit. Wiring sizes in accordance with manufacturer's recommendations for distances required.

2.3 **MANUFACTURERS**

.1 Acceptable Products:

.1 Emergi-Lite Canada (Thomas & Betts)

.2 Stanpro

.3 Beghelli Canada

Part 3 - Execution

3.1 **INSTALLATION**

.1 Install unit equipment and remote mounted fixtures as indicated on drawings.

3.2 **PROTECTION**

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by emergency lighting installation.

END OF SECTION

Part 1 - General

1.1 RELATED SECTIONS

.1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 Comply with latest edition, including Amendments, of the following Codes and Standards.

.2 Ontario Amendments to CSA-C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations (OESC).

.3 Ontario Building Code (OBC).

.4 CSA C22.2 No. 141, Unit Equipment for Emergency Lighting.

.5 CSA C860, Performance of Internally-Lighted Exit Signs.

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data: Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

Part 2 - Products

2.1 SELF-POWERED UNITS

.1 See Luminaire Schedule for products.

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 datasheets.

3.2 INSTALLATION

.1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.

.2 Connect fixtures to exit light circuits as shown on drawings.

.3 Ensure that exit light circuit breaker is locked in on position.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 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 SUBMITTALS

.1 Submit shop drawings for products specified in this Section.

.2 Include data sheets for cabling, faceplates, terminal cabinets, racks, etc., and proposed cabling testing sheets.

.3 Submit following:

- .1 proof that final installation drawings have been reviewed by a Registered Communications Distribution Designer (RCDD);
- .2 samples of each type of data/voice jack complete with faceplate;
- .3 samples of patch-cord;
- .4 sample of proposed labelling of components and wiring;
- .5 sample of proposed test sheet;
- .6 copy of tester calibration certificate;
- .7 written confirmation that telecommunication system vendor is Manufacturer valid certified system vendor for at least duration of contract work and is in good standing at time of Bid submission;
- .8 copy of system Manufacturer warranty;
- .9 as-built drawings, including the following:
  - .1 provide an As-Built drawing of the cable installations for all drawings included in this specification with any changes due to site conditions;
  - .2 cable routes and outlet locations;
  - .3 numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided;
  - .4 Contractor shall annotate the base drawings provided by the Owner and return a hard copy (same plot size as originals) and 1 (one) electronic copy in Adobe Acrobat PDF format;
  - .5 All documentation shall be submitted to the Customer within 10 working days of the completion of the project.

1.2 REFERENCE STANDARDS

.1 Comply with latest editions of following, as applicable for project:

- .1 ANSI/TIA-568-C family of Telecommunications Standards, including:
  - .1 ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises;
  - .2 ANSI/TIA-568-C.1 - Commercial Building Telecommunications Cabling Standard;
  - .3 ANSI/TIA-568-C.2 - Balanced Twisted-Pair Telecommunication Cabling and Components Standard;
  - .4 ANSI/TIA-568-C.3 - Optical Fiber Cabling Components Standard;
  - .5 Issued addenda.
- .2 ANSI/EIA/TIA 568A - Commercial Building Telecommunications Cabling.
- .3 ANSI/EIA/TIA-569-C (CSA T530) - Commercial Building Standards for Telecommunications Pathway and Spaces;
- .4 ANSI/EIA/TIA 606-B (CSA T528) - Administration Standard for Telecommunications Infrastructure of Commercial Buildings;

.5 ANSI/EIA/ TIA-607-B (CSA T527) - Grounding and Bonding Requirements for Telecommunications in Commercial Buildings;

.6 ANSI/EIA/TIA 607-Commercial Building Grounding and Bonding Requirements for Telecommunications (CSA T527).

.7 ANSI/EIA/TIA TSB 67-Performance Specification For Field Testing Of Unshielded Twisted Pair Cabling Systems.

.8 CSA C22.2 No. 214 -Communication Cables.

.9 CENELEC EN 50173 -Performance Requirements for Generic Cabling Schemes.

.10 NEMA WC 63 -Performance Standard For Field Testing OD Unshielded Twisted Pair Cabling System.

.11 All UTP. (Unshielded twisted pair) products are to be produced from a single manufacturer unless otherwise stated.

.12 Latest Building Industry Consulting Service International (BICSI) standards;

.13 Applicable local Building Codes.

.2 Work to be installed by system manufacturers certified system installers/vendors who are certified and experienced in implementing selected data cabling system and to perform related testing programs.

.3 System final installation layout to be designed and/or reviewed by a RCDD. Submit shop drawings verifying this requirement.

1.3 **APPLICATION SUPPORT**

.1 Structured cabling system serves as a vehicle for transport of data, video, and voice telephony signals throughout network from designated demarcation points to outlets located at various desk, workstation, and other locations as indicated on drawings and described herein. Applications standards supported include, but be not limited to:

.1 IEEE 802.3;

.2 10BASE-T;

.3 IEEE 802.5;

.4 4 Mbps;

.5 16 Mbps (328 ft [100 m], 104 Workstations);

.6 TP-PMD.

.2 In addition, these links/channels to be capable of supporting evolving high-end applications such as:

.1 100 Base-T;

.2 52/155 Mbps ATM;

.3 77 Channel Analogue Broadband Video out to 550 MHz.

.3 Gigabit cable performance to be capable of supporting existing and evolving applications including:

.1 AES/EBU Digital Audio;

.2 270 Mbps Digital video;

.3 622 Mbps 64-CAP ATM;

.4 1000 Base-T Gigabit Ethernet;

.5 1.2 Gigabit ATM.

1.4 **WARRANTY**

.1 System manufacturers to provide a minimum twenty (20) year full parts, labour, and performance warranty on all passive components including structural cabling system. These warranties to be provided in written certificate form and that guarantee following:

.1 passive system components, e.g. patch panels, UTP cable and outlet jacks, are free from manufacturing defects in material or workmanship;

.2 approved cabling systems exceed specifications of TIA-EIA 568B.2.1 standards for specified category, in particular for attenuation and near-end cross-talk, loss and bandwidth requirements;

.3 installation supports applications for which it was originally designed as well as future versions of system performance specifications and any future applications using TIA/EIA 586B.2.1 component and cabling standards;

.4 replacement or repair of any originally installed registered system component to be completed at no cost for parts and labour to Owner during warranty period. Any components repaired or replaced to be warranted for remainder of warranty.

.2 System manufacturers to provide in writing to Owner that in event of demise or failure or change in approved status of installing certified system installer/vendor, manufacturer to be responsible for providing another certified system installer/vendor to fulfil remainder of warranty conditions.

.3 Claim for repair procedure to comprise of contractor being notified of a problem and who will conduct necessary tests and repairs to correct problem. Should contractor be unable to resolve problem, contractor to contact system supplier who will take necessary action and provide any technical support to correct problem.

.4 Initial response time to a repair claim for a registered system to be within four (4) hours from time Contractor was notified of system fault.

.5 Ensure that selected network cabling component manufacturer includes a system warranty that is a true "end-to-end" structured cabling system warranty from a single manufacturer, which includes data/voice communications outlet and patch cord at workstation, horizontal copper cabling, and patch panel and patch cords at LAN room. In addition, this warranty is to be valid with selected fibre optic cabling solution.

1.5 **SCOPE OF WORK**

.1 This document describes the products and execution requirements related to the installation and maintenance of the IT Network cable distribution systems for wireless, workstation, voice (VoIP) and data. This Section provides minimum standards for provision of a structured cabling system to network computer systems for complex. Requirements for network electronics are responsibility of Owner Network Integrator. Work includes but is not to be limited to following:

.1 Supply, install and test a complete Horizontal and Riser telecommunications system as specified herein and shown on the drawings provided.

.2 The data cabling system shall comprise of the following subsystems, supplied unless noted otherwise.

.1 Termination of new horizontal cabling on a patch panel in the network closet.

.2 Provision of modular jacks and faceplates at the work area outlets.

.3 Electrical grounding of network rack, as per code.

.4 Physically secure the network rack to the floor or wall.

.5 Labeling and testing of all cabling systems as specified.

.6 Provision of all specified system documentation. (i.e. As-built drawings)

.7 Supply and installation of horizontal cable distribution system using J-Hooks or approved equivalent cable supporting structure (as required) beyond conduit system already installed.

.8 Provide Cat 6 Modular Patch Panels for termination (new install).

.9 Rack and Racking accessories to be installed.

.10 Install UPS into base of rack.

.3 coordination of system requirements and integration requirements with integrated systems.

.2 The local area network system must be "protocol neutral" and provide users access into a variety of resources from any location within the Complex. An Ethernet backbone shall be utilized for the system with intelligent network switches coordinating and managing data flow. The wiring configuration is based on a "physical star" topology in which cabling runs emanate in a radial pattern from the main data communications room in which the intelligent switches are located.

.3 Technical features of the structural cabling plan include:

.1 use of Category 6 cabling to each data/voice outlet;

.2 use of modular Category 6 jacks at workstation ends of data/voice cabling run;

.3 backward compatibility to categories 5e, 5 and 3.

.4 The network cabling system vendor shall coordinate with Electrical Contractor to ensure that properly sized conduits, back boxes outlet boxes, junction boxes and floor boxes are provided of sufficient size as per EIA/TIA Standards to accommodate CAT 6 system wiring and devices, with particular emphasis on bending radii of cabling. Conduit and boxes not meetings Cat 6 standard requirements must be replaced.

.5 System to be designed to support minimum 802.11a/b/g/n/ac standards.

1.6 **SYSTEM SUPPLIER QUALIFICATIONS**

.1 System supplier qualifications include:

.1 being an established communications and electronics contractor that has and currently maintains a locally run and operated business for at least five years and holds applicable provincial and local licenses;

.2 be an Authorized Distributor or established franchisee for manufacturer of product/system proposed with full Manufacturer warranty privileges and be capable of providing post warranty service;

.3 employ technicians who have attended and successfully completed Manufacturer technical certification classes for proposed system;

.4 show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to system on a 24-hour/7-day basis;

.5 maintain at their facility necessary spare parts in proper proportion as recommended by manufacturer to maintain and service equipment being supplied.

.6 The Contractor will be responsible for cable installations at the new facility. Installations must conform to Belden IBDN Certified System Vendor (CSV). http://www.belden.com/resourcecenter/prutnerportal/certifiedsvstemvendor/Ce1tified-System-Vendor.cfm

.7 All cables and related terminations and support shall be furnished, installed, wired, tested, labeled, and documented by the Contractor as detailed in this document.

.8 The Contractor shall have access to professional staff with an R.C.D.D. designation (The Registered Communications Distribution Designer) to review drawings to ensure that they conform to the wiring standards as indicated in this Document.

.2 Submit written evidence of qualifications to Consultant for approval.

Part 2 - Products

2.1 **HORIZONTAL CABLING**

.1 For all new applications a UTP cable shall be used.

.2 This cable shall consist of #24 AWG (CAT 6) solid conductors, formed into four individually twisted pairs and enclosed in a thermoplastic jacket.

.3 The cable shall be rated CMP FT-6 Belden/CDT.

.4 Performance shall comply with the latest draft of ANSII EIA/TlA 568-A.

.5 Cat 6 Data cable jacket to be Yellow in colour.

2.2 **OUTLETS**

.1 GigaFlex PS6+ modules jacks AX IOI 065 (White).

.2 Wall faceplates shall be provisioned accordingly for single or multi-port outlets, Belden/CDT (White).

.3 Furniture outlet adapters shall be MDVO Side Entry boxes A0645273 (White).

.4 Furniture outlet adapters to be determined for Floor Monuments. Where applicable, MDVO (Mobile Dynamic Virtual Organizations) blank inserts shall be used in empty ports in wall and furniture jacks.

.5 Jacks colours and faceplate colours to be different to distinguish different systems as per Owner requirements. Confirm exact colour finishes and T568 pinning arrangement with Consultant prior to ordering.

.6 Quantity of jacks and configuration of faceplates are as detailed on drawings.

.7 Provide snap-in plastic dust covers on blank outlets and unused outlets. Blank covers to match faceplate colours.

2.3 **PATCH PANELS**

.1 482 mm, 19" Rack Mountable, 48 / 24 port, 8 position RJ45 style, High Density patch panel (Belden/CDT)

.2 Category 6 Cables - Horizontal and Riser Terminations: GigaFlex PS6+ Belden/CDT, 2U, 48 Port, Black AX101458 GigaFlex PS6+ Belden/CDT, IU, 24 Port, Black AX101456

.3 Pinout Termination Sequence is T-568-A.

.4 Patch panel system to include required accessories such as bezels, harnesses, pigtails, connectors, jumpers, and retaining rings, interlay racking panels, horizontal wire managers etc., to provide for patch cord management.

2.4 **PATCH CORDS & CABLES**

.1 Patch cables to be supplied/procured by Vendor or General Contractor for use in the Network Closet only.

.2 All Patch cables should be Belden/CDT brand.

.3 Patch cable quantity should be equal to quantity of all ethernet cabling installed.

.4 City staff will be responsible for patch cable installation.

.5 Each patch cable should be Category 6 Ethernet cabling - Ultra thin 28AWG - length should be 7 feet.

.6 Outer jacket for all patch cables should be black in color.

.7 Patch cords to be of different colours to distinguish different systems as per Owner requirements. Confirm exact colour finishes with Consultant prior to ordering.

2.5 CATEGORY 6 VOICE TERMINATIONS

.1 Category 6, 96 and 288 pairs punch down block bases for termination of UTP cabling and cat 6 connecting blocks; finished in white; can be interlocked and stacked to accommodate system capacity; of types to be either rack mounted or panel mounted to suit application and room requirements.

.2 Category 6 cross connect jumper wire.

.3 110 connecting tool, designation strips, labels and wiring distribution rings.

.4 Cable HUB harness or pigtails as required.

2.6 OPEN EQUIPMENT RACKS

.1 Open type, equipment racks to be heavy duty type, standard EIA 19" free standing racks, complete with but not limited to following requirements to be supplied by the Cabling Contractor:

- .1 steel or aluminum construction;
- .2 minimum 1800 mm in height, with 4 posts design for racks containing servers and other active head end equipment;
- .3 polyurethane finish or enamel painted finish;
- .4 double sided 12/24 tapped holes;
- .5 heavy duty base with provision for bolting to floor;
- .6 high capacity cable organizer channel with snap on cover;
- .7 full height vertical cable channels 150 mm x 150 mm (6" x 6") on both sides of rack;
- .8 horizontal cable management channel - minimum one for each patch panel;
- .9 front and rear cable management provisions (typically only last 150 mm (6") of cabling to connector to be loose and not in channel);
- .10 rack mounted multi- outlet power strips with surge protection, integral breaker, pilot light and power cord with twist lock type plug and receptacle provisions; number of outlets to be same as number of active devices mounted on racks;
- .11 required mounting hardware, label kits, velcro style fasteners and ancillary devices.

.2 Each rack to include grounding provisions to meet previously listed standards, which include but are not limited to following provisions:

- .1 copper ground strip mounted on side rail extending full height of rack;
- .2 equipment jumper kits, to bond network equipment to rack ground strip;
- .3 common bonding network to rack jumper kit, to bond rack to room common bonding network;
- .4 hardware including, copper compression HTAPS, paint piercing washer kits, bonding screws and electrostatic discharge port kits.

.3 Racks to be of size and quantity to accommodate respective number of patch panel ports to suit number of required drops, quantity of network electronic components as directed by Owner network integrator, uninterruptible power supply unit and an additional 20% spare capacity for future expansion.

.4 Wall mounted equipment racks to be provided where required and with similar applicable features as per specified floor mounted products, but sized to suit application and complete with wall mounting hardware and hinged feature to allow access to rear of rack.

.5 Within LAN rooms, provide flexible steel type wire basket tray to manage cabling to and from racks. Refer to cable tray section for tray requirements.

.6 New Communication racks shall be:

.1 Mandatory:

.1 Cable Talk CTR-1977C-P48-B (4-post rack w/ Vertical Cable Management) or approved equivalent by the City/Owner

.2 CableTalk CTR-1977-DS-B (2-Post Rack w/ Vertical Cable Management) or approved equivalent by the City/Owner.

.3 Cable Talk CTR-CMS-16-B vertical cable manager or approved equivalent by the City/Owner.

.4 CableTalk CTPBV-1277-SD-B 15 amp. Vertical power bar "switch disabled" or approved equivalent by the City/Owner.

.5 Cage nuts NUT-CAGED-10-32K (100 pack) for 4-post racks

.2 Optional: (if requested by the City)

.1 Cable Talk CTRS-F-1812-B (Single sided fixed shelf) or approved equivalent by the City/Owner.

.2 Cable Talk CTRS-F-1820-B (Centre Mounted shelf) or approved equivalent by the City/Owner.

2.7 **EQUIPMENT CABINETS**

.1 Enclosed type, equipment cabinets to be heavy duty type, complete with but not be limited to following requirements:

.1 steel construction frame work with steel or aluminum construction sides, backs, tops and bottom panels;

.2 ventilation fans and louvers;

.3 minimum 1800 mm (70") in height;

.4 polyurethane finish or enamel painted finish to Consultant's approval;

.5 double sided 12/24 tapped holes;

.6 sized and spaced for standard EIA 19" racking;

.7 heavy duty base with provision for bolting to floor;

.8 high capacity cable organizer channel with snap on cover;

.9 full height front and back hinged lockable doors with handle operators with locks and keys; keys to be keyed alike as per Owner direction;

.10 full height vertical cable channels 150 mm x 150 mm (6" x 6") on both sides of rack;

.11 horizontal cable management channel - minimum one for each patch panel;

.12 front and rear cable management provisions (typically only last 150 mm (6") of cabling to connector to be loose and not in channel);

.13 rack mounted multi- outlet power strips with surge protection, integral breaker, pilot light and power cord with twist lock type plug and receptacle provisions; number of outlets to be same as number of active devices housed in equipment enclosure;

.14 required mounting hardware, label kits, Velcro style fasteners and ancillary devices.

.2 Include grounding provisions for each cabinet, to meet previously listed standards, which include but are not limited to following provisions:

.1 copper ground strip mounted on side rail extending full height of rack;

.2 equipment jumper kits, to bond network equipment to rack ground strip;

.3 common bonding network to rack jumper kit, to bond rack to room common bonding network;

.4 hardware including, copper compression HTAPS, paint piercing washer kits, bonding screws and electrostatic discharge port kits.

.3 Wall mounted equipment enclosures to be provided where required with similar applicable features as per specified floor mounted products, but sized to suit application and complete with wall mounting hardware and hinged feature to allow access to rear of cabinet.

.4 Cabinets to be of size and quantity to accommodate respective number of patch panel ports to suit number of required drops, quantity of network electronic components as directed by Owner network integrator, uninterruptible power supply unit, and an additional 20% spare capacity for future expansion.

.5 Acceptable manufacturers are:

.1 listed network cabling system manufacturers;

.2 Devtek;

.3 Cable-Talk;

.4 Hoffman;

.5 Cannon.

2.8 WIRELESS LAN INFRASTRUCTURE

.1 Provisions for a wireless LAN infrastructure to be provided with 100% coverage of entire complex, utilizing structured network cabling system as a rough-in for future wireless access points (WAP) located in ceiling spaces. Generally, quantity of outlets to be identified on drawings, but Electrical Divisions contractor to perform a site signal survey/audit of coverage areas and confirm if additional rough-in jacks are required. Prepare audit immediately after structure of concrete and metal studs are in place. Submit copy of audit to Consultant to review.

.2 Locations may generally be shown on drawings, however, following criteria to be followed:

.1 back-of-house above accessible ceiling tile or high up in open ceiling areas as confirmed with Consultant;

.2 public spaces priority:

.3 in service areas adjacent public areas;

.4 in light cove if WAP is hidden;

.5 with access panel (location identified).

2.9 **ACCEPTABLE NETWORK CABLING SYSTEM MANUFACTURERS**

.1 Horizontal network copper cabling infrastructure is to be end-to-end solution from a single manufacturer, which includes data communication outlets and patch cords at workstations, and patch panels and patch cords at LAN/Telecommunication rooms. To this horizontal network is integrated fibre optic cabling infrastructure from same manufacturer or approved listed herein, maintaining full warranty requirements for systems comprising this Section.

.2 Acceptable network cabling system manufactures for provision of horizontal network copper cabling infrastructure are:

.1 Belden/CDT;

.2 Commscope Systimax/Uniprise;

.3 Panduit;

.4 TE (Tyco AMP);

.5 Hubbell;

.6 Leviton.

2.10 **ACCEPTABLE CONTRACTORS**

.1 Contractor selected for installation of structured cabling system to provide confirmation of following:

.1 detailed knowledge and experience in fibre optic cabling and category grade rating copper UTP wiring installations;

.2 detailed knowledge and experience in installation of Intelligent HUB equipment;

.3 experience in troubleshooting and problem solving in data communication networks.

.4 ability to provide system Manufacturer certified warranties;

.5 certified and valid proof of being system Manufacturer authorized vendor.

.2 Refer also to supplier requirements specified in Part 1.

Part 3 - Execution

3.1 **INSTALLATION OF NETWORK CABLING - GENERAL**

.1 Installation shall conform to the applicable codes and standards (as listed in 1.2.) manufacturer's recommendations, and best industry practices.

.2 Grounding of each distribution rack to the communications ground bus system shall be performed by the structured cabling contractor. Mounting and fastening of the distribution rack (where applicable) to the floor shall be performed by the cable contractor.

.3 Cables shall be installed in trays and or conduits as provided by the electrical contractor.

.4 No splicing of any structured cabling will be permitted.

.5 Properly handle and install structured network cabling in accordance with Manufacturer specifications. Avoid undue pulling tension, abrasion, or rough handling to ensure that cables will permit transmission up to required category rating design speed for cables. Install cables without splices or cuts to ensure elimination of reflections, discontinuities, impedance mismatches, etc. maximum horizontal length of copper cabling from workstation to network switch is not to exceed 90 m (295') or less if recommended by system manufacturer to meet required category grade rating performance standards. Maximum length of patch cables (either cross connects or interconnecting with electronic equipment to connect devices at work area outlet), to be a total of 10 m (30'). Maintain system Manufacturer minimum channel lengths as confirmed with system manufacturer. Provide cable loops in accordance with Manufacturer instructions.

.6 Unless otherwise noted or where cable tray is shown for such use, run cabling in conduit. Install pull cords for future use, in conduits extending between floors.

.7 Generally, no more than two (2) 90-degree changes in direction are recommended for cable installed in conduit without pull boxes and not more than 40% fill ratio. Confirm exact conduit bending radii restrictions and fill ratios with system manufacturer and comply with those standards.

.8 With consideration in minimizing alien crosstalk to levels as per BICSI standards and Manufacturer standards, dress cables in a neat and orderly fashion from entrance of communications closet to relay racks using vertical and horizontal cable management trays and paths. Do not exceed Manufacturer distance limitations to maintain required category rating performance standards.

.9 Care to be taken to ensure that during installation, nicks, abrasions, burning and scuffing of cable is prevented. Replace cables found to be damaged regardless of whether cable passes category grade rating or fibre performance testing standards.

.10 Secure bundled cables transitioning between floors via ladder cable tray, to vertical ladder sections with Velcro wraps. Use waterfall (rounded transition) fittings for cable changing from a horizontal path to a vertical one. This is to maintain minimum bend radius for cabling system. Support cables running through risers between floors such that they are properly supported for their weight, especially in situations with high pair count cables and large bundles.

.11 Electrical Contractor and telecommunication system vendor to provide coordination of structured cabling system with other systems as required.

.12 Required necessary drilling and anchoring components to be installed before any horizontal cable is installed.

.13 Route horizontal cable into equipment racks/enclosures and neatly bundle with Velcro cable ties. Maximum number of cables per bundle to be 25.

.14 Securely mount fire retardant plywood on wall in each telecommunications room or closet.

.15 Review installation of conduits and boxes and advise Electrical Contractor where products do not comply with CAT 6A Standards. Ensure that products are replaced as required to meet standards.

.16 Cables wraps are to be Velcro type and are not to be over tightened.

.17 Provide grounding and bonding requirements as specified in Section titled Grounding and Bonding.

3.2 **DATA CABLES**

.1 All New LAN Data cable is to be Category 6 and is to be terminated on Category 6 connecting hardware at the wall termination for each location, and rack mounted patch panels in the communication closet.

.2 Label and test all cabling as detailed in this specification.

3.3 **HORIZONTAL DISTRIBUTION SYSTEM**

.1 Cabling contractor to supply and install a horizontal distribution system using J-hooks or approved equivalent supporting structure, beyond provided tray/conduit, as per provided drawings.

.2 Supporting cable structure is to be installed into steel support structure or concrete above.

.3 Distribution system to be designed and installed according to consultation with Customer.

.4 Cable distribution to be designed according to best practices and to maintain a clean ceiling space.

.5 J-Hooks distribution to be designed with cable spans not to exceed 4 Feet between Zone conduit and J-Hook or J-Hook to J-Hook where applicable.

3.4 **ACCESS POINT INSTALLATION**

.1 Termination of cable for Access Point on SMB (Surface mount box) with 10 feet service slack in ceiling, or secure to supporting structure (in case of no ceiling).

.2 Install Cisco access points by patching to installed SMB from rack in network closet via patch cable.

.1 Cabling for Wi-Fi Access Points shall be CAT6A, Plenum rated (FT6), jacket color shall be yellow.

.2 Cabling for Wi-Fi 33 Access Points shall be terminated at the end of the patch panel, separate from the data jack cables. (i.e. on a 48-port patch panel, data jacks terminated on ports #1-40, AP’s terminated on ports #41-48).

3.5 **INSTALLATION OF PATCH PANELS & ACCESSORIES**

.1 Provide patch panels onto racks in locations. Provide terminating hardware and connectors to suit incoming and outgoing cabling. Clearly identify each port. Provide patch cords as required. Install devices in accordance with system Manufacturer requirements.

.2 Terminate both data and voice horizontal cabling onto patch panel punch down using Manufacturer recommended tools. Bundle cabling in neat configuration and secure to patch panels and rack assemblies. Typically dedicated separate patch panels are required for data and voice.

.3 Install rack enclosures on walls. Neatly bundle wiring within wiring management channels. Do not over tighten Velcro straps. Ground racks as required.

3.6 **COPPER CABLE INSTALLATION**

.1 Run horizontal, UTP cables continuous from end to end with no splices. Install horizontal cables in Star topology, emanating from rack mounted patch panel(s) and terminating on data outlet faceplates in rooms or other workstation locations. maximum length for horizontal cables to not exceed 90m (295'). Maximum length for patch cords at patch panel to not exceed 3m (10').

.2 Install conductors in cable tray and conduit runs designated for data and voice conductors. Do not fasten conductors and conduit to suspended ceiling support systems. Support conduit to building structure slab independent of other support.

.3 Terminations to involve as little outer jacket removal as possible and cable pairs "untwisting" is to not exceed 6 mm (1/4").

.4 Provide slack cable to allow for minor workstation relocations. Provide a coil of slack cable of an approximate 2 m (6') length for each workstation outlet run.

.5 Where conduits and/or cable tray is not being provided, conductors within accessible ceiling spaces to be properly bundled using "Velcro" type wraps and supported with "J" hooks. Secure "J" hooks to ceiling slab structure. Install conductors following building lines. Do not fastened conductors to suspended ceiling support systems. Obtain Consultant's approval in use of "J" hooks. Unless otherwise noted, drops down from ceiling spaces to consist of cabling installed in vertical conduits running down within walls to outlet boxes and terminating onto jacks.

.6 For main voice backbone cabling from main telecom room, provide 110 connectors and mounts on hardwood backboards on walls, as required. Design system layout to best suit incoming and outgoing cables. Properly punch down cabling with Manufacturer required tool and label each connector as required.

.7 Run interconnect cables neatly secured and bundled across connectors and between banks of mounts. Use D-rings to their full advantage. Neatly bundle pigtails and secure to BIX/110 connectors.

.8 Align mounts in straight formations to provide a neat installation and to minimize interconnect wiring lengths.

.9 Coordinate with Owner network integrator to determine exact requirements for telephone service interconnections.

.10 Provide jumpers/pigtails to interconnect backbone wiring to rack mounted voice patch panels where horizontal voice cabling is terminated.

.11 For horizontal copper backbone cabling, multi- pair conductor cabling is preferred. If available only in limited number of pair cabling, provide multiple runs to provide quantity as identified on drawings, and increase conduit diameters to suit exact number requirements, in accordance with of standards and codes.

3.7 PENETRATION THROUGH FIREWALLS

.1 Provide a conduit sleeve where horizontal cables penetrate firewalls. Size conduit sleeve at 40% fill ratio with a plastic bushing at both ends.

.2 After conduit sleeve is installed, fill opening around conduit with firestop and smoke seal materials.

3.8 INSTALLATION OF OUTLETS

.1 Connect each data/voice outlet with a 4-pair, UTP cable. Test and identify each outlet and faceplate. Wire and connect data/voice jacks back to respective dedicated racks in LAN/TEL rooms. As detailed, extend voice cabling from voice patch panels to wall mounted 110 connectors, using patch cords, cross connects/jumpers, etc. as required.

.2 Provide outlet jack/faceplate configuration as detailed on drawings.

.3 Drawings identify data jacks for wireless access point receivers (antennae). These locations are approximate. Confirm exact locations during onsite radio frequency studies. Allow for jacks to be repositioned up to 4m (15') to suit results of studies. Perform studies after completion of construction of interior structures. If studies are not performed at discretion of Owner, obtain direction from Consultant to leave slack coiled length of cable on each run, allowing for repositioning.

3.9 SEPARATION OF DATA COMMUNICATION CABLES FROM SOURCES OF ELECTROMAGNETIC INTERFERENCE

.1 Separate data communication cables from sources of electromagnetic radiation in accordance with TIA Standard Proposal SP-2072 and following:

.1 FT-6 rated data cabling raceway and power conductors (2 kVA power circuits) raceway require 125 mm (5") clearance;

.2 clearance increases up to 600 mm (24") for power circuits over 5 kVA.

.3 for large motor, transformers, power panels, etc., required clearance is 1m (39");

.4 route cables to avoid direct contact with steam piping, hot water piping or other heat sources to avoid thermal degradation.

3.10 INSTALLATION OF RACKS

.1 Provide racks and secure to floor with bolts and concrete anchors.

.2 In locations where more than one rack is required, butt multiple racks together. Provide wiring channel interconnection such that wiring from rack to another is not exposed.

.3 For open racks, provide metal raceway chimney channel for conductors extending down from ceiling, such that wiring is not exposed. Secure channel to rack and ceiling.

.4 Run wiring neatly bundled within wiring management channels. Do not over tighten Velcro tie wraps such that they deform cable jacket. Velcro straps to easily slide along length of cable. Velcro tie wraps used in plenum spaces to be CMP/FT-6 rated.

.5 Protect cable from any obstructions using appropriate grommeting in roof of rack.

.6 Properly ground and bond rack and equipment to room ground bus as per specifications and to standards of TIA/EIA 607.

3.11 INSTALLATION OF EQUIPMENT ENCLOSURES

.1 Provide equipment enclosures and secure to wall/floor/ceiling as required with suitable anchors.

.2 In locations where more than one enclosure is required, butt multiple enclosures together. Provide wiring channel interconnection such that wiring from enclosure to another is not exposed.

.3 Provide metal raceway chimney channel for conductors extending down from ceiling, such that wiring is not exposed. Secure channel to enclosure and ceiling.

.4 Provide suitable power supply to cabinets having fans and other active components or designated as such.

.5 Run wiring neatly bundled within wiring management channels. Do not over tighten Velcro tie wraps such that they deform cable jacket. Velcro straps to easily slide along length of cable. Velcro tie wraps used in plenum spaces to be CMP/FT-6 rated.

.6 Protect cable from any obstructions using appropriate grommeting in roof of enclosure.

.7 Properly ground and bond enclosure and equipment to room ground bus as per specifications and to standards of TIA/EIA 607.

3.12 SYSTEM IDENTIFICATION

.1 Provide a complete identification system that clearly designates following:

- .1 horizontal cable;
- .2 workstation (or faceplate);
- .3 horizontal/passive patch panel port;
- .4 switch/active patch panel port;
- .5 patch cords;
- .6 switch rack.

.2 Obtain Owner approval of identification format, prior to start of work. Format to comply with Owner standards. Submit proposed identification system and nomenclature with shop drawing submission.

.3 Provide adhesive cable labels to meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D 16). In addition the labels shall meet in the general exposure requirements in UL 969 for indoor use.

.4 Self-laminating vinyl construction cable labels with a white printing area and a clear tail that self laminates the printed area when wrapped around the cable. The clear area should be of a sufficient length to wrap around the cable at least one and a half times.

.5 Mechanically print labels using a printer and follow guideline in ANSJ/TIA/EIA 606 for colour codes. Hand written labels shall not be permitted.

.6 All cables shall be labeled at the following locations:

- .1 Each end of data cable lines;
- .2 Front of Patch Panel- Data patch panels;
- .3 Front of End User faceplates - All work area outlets;
- .4 All Data and Analog Line horizontal UTP cables shall be labeled identically using the format as shown below
  - .1 C6-XX- AAA.
  - .2 C6 identifies Cat 6 cable.
  - .3 XX - identifies the floor and particular Comm. Room, where applicable (ex. 4N - floor, North side, 3W - floor 3, west side)
  - .4 AAA identifies the incremental cable number (i.e. 001, 002, 003 etc.…).

3.13 CABLE TESTING & SYSTEM CERTIFICATION

.1 Structured cabling system certification to include 100% cable testing and verification for an EIA/TIA required category grade rating solution.

.2 Perform verification of each cable and document on a cable testing sheet forming part of hard and soft copy documentation supplied at end of installation. Testing sheets to list detailed performance test measurements as requested and as required to prove compliance with referenced standards. Also include summary sheet of passes, failures and rectified failures. Submit sample of test sheet with shop drawings.

.3 Comply with system Manufacturer testing and certification procedures.

- .1 Horizontal distribution shall be tested and certified in accordance with ANSJ/EIA/TIA and BICSI standards.

.2 Copper cable testing equipment testing Cat 6 cable shall be performed in accordance with ANSI/BIA/TIA 568A standard, using level 3, Category 6 cable testers. All testing software shall be the latest version, and licensed.

.3 Tests shall include Wire Map, Leogtl1, Insertion Loss (Attenuation), NEXT, (pair to pair), PSNEXT, ELFNEXT (pair to pair) PSELFEXT, RETURN Loss, ACR, PSCAR, Propagation Delay, Delay Skew. Test results shall be recorded.

.4 100% of cables must be tested. Up to 5% of test may be redone in the presence of the Owner.

.5 Any failures shall be corrected expeditiously and retested. Record of test shall be submitted in both printed and soft copy. (MS Word or Excel Format only).

.6 Replace cable not passing testing procedure, in its entirety. No splicing is permitted in repair of any defective cable.

.4 Reports:

.1 Cabling contractor shall submit test results in hard copy binder form which are to be left in the Communication closet. Electronic copies of the results are to be provided to the Customer in MS Excel, .pdf or Word format

.2 Cabling contractor to produce a cable test summary report based on the cable schedules.

.3 The report should indicate for each cable when it was tested successfully, the result and the length.

.4 The entire report must be signed by an authorized person for the cabling contractor and the end of the project.

.5 The test result documentation must be submitted to the owner for review no later than 10 working days following the completion of the installation.

3.14 SYSTEM TRAINING & INSTRUCTIONS

.1 Provide training of Owner designated staff on principles of connections and operations to system. Clearly instruct on procedures of disconnections and reconnections to accommodate changes and relocations of connected equipment.

END OF SECTION

Part 1 - General

1.1 SUBMITTALS

.1 Submit shop drawings for products of this Section. Provide connection wiring schematic drawings for each system. Provide where applicable, proposed software screens, block system diagrams and sequence of operations.

1.2 ABBREVIATIONS & ACRONYMS

.1 AWS: Advanced Wireless Service.

.2 BDA: Bi-Direction Amplifier.

.3 BOM: Bill-of-Material.

.4 BRS: Broadband Radio Service.

.5 DAS: Distributed Antenna System.

.6 LMR: Land Mobile Radio.

.7 LTE: Long Term Evolution.

.8 MTBF: Mean Time Between Failure.

.9 NMS: Network Management System.

.10 PCS: Personal Communications System.

.11 PSN: Public Safety Network.

.12 RF: Radio Frequency.

.13 RoF: Radio-over-Fibre.

.14 RoHS: Restriction of Hazardous Substances.

.15 RSL: Received Signal Level.

.16 SISO: Single-Input, Single-Output.

.17 SMR: Specialized Mobile Radio.

.18 SMS: Short Message Service.

.19 SNIR: Signal-to-Noise Interference Ratio.

.20 SNMP: Simple Network Management Protocol.

.21 VSWR: Voltage Standing Wave Ratio.

.22 WSP: Wireless Service Provider.

Part 2 - Products

2.1 GENERAL DESIGN REQUIREMENTS

.1 Design considerations including location of current and future structures, building construction, RF measurements, interference, and power provisioning to be considered in planning process for DAS. Provide a model demonstrating proposed coverage as well as perform a full site survey/RF study during construction/installation.

.2 Design, supply and install a Host Neutral Distributed Antenna System infrastructure that provides total coverage for areas of facility. Components including but not limited to, cable, connectors, antennas, distribution panels, splitter and amplifiers are to be designed, supplied and installed. Backbone to be a dedicated structured network cabling system. DAS system to be approved by WSPs.

.3 Coordinate with end users to determine carrier companies that supply various sources of signals to building and which system is to be designed for, supplied installed, and have signed agreements with end user. Determine WSPs that can provide system for building. Obtain detailed requirements for service and approvals. Obtain required approvals.

.4 This specification describes technical and performance criteria for deploying a Neutral-Host Distributed Antenna System capable of supporting WSP. DAS components specified include but are not limited to:

.1 Donor Antennas and Coverage Antennas;

.2 Coax Cable;

.3 Coax Connectors, Splitters, Combiners, Couplers;

.4 Fibre-Optic Cable, Fibre-Optic Connectors, and Fibre-Optic Jumpers;

.5 Bi-Directional Amplifiers (BDA);

.6 Fibre-Optic Master Unit;

.7 Fibre-Optic Remote Units.

.5 DAS to provide coverage for WSPs listed below on frequencies currently being used by designated WSPs:

SERVICE	UPLINK	DOWNLINK
Cellular	824 - 849	869 - 894
PCS	1850 - 1915	1930 - 1995
AWS	1710 - 1755	2110 - 2155
Lower 700 Band	698 - 716	728 - 746
Unpaired 700 Band	716 - 728	
Upper 700 Band	746 - 776	776 - 805
800 Band	806 - 824	851 - 869
900 Band	896 - 902	935 - 941
BRS/EBS	2496-2690	

.6 Network Management:

.1 NMS: Capable of alarm, monitor, configuration, and control of all Active Components.

.2 SNMP Integration: capable of integration with 3rd party SNMP based NMS products for alarm purposes and provide alarming information.

.7 On a per channel basis, downlink RSL for each frequency band to meet or exceed for Cellular, PCS, AWS, Commercial 800/900 MHz - 75 dBM to 95% of building including stairwells, elevators, basement, and garage.

2.2 **COMPONENTS**

.1 System components are to be approved for system by Industry Canada.

.2 Broadband Donor Antennas: Broadband Donor Antennas to feature a multi-band design, accommodating Cellular, PCS, LMR and AWS frequencies in a single small antenna.

.1 Electrical:

.1 Frequency bands, 806 - 960 MHz and 1710 - 2200 MHz.

.2 VSWR ≤ 1.8.

.3 Gain: 806-960 ≥ 10.5 dBi, 1710 - 2200 ≥ 12 dBi.

.4 Maximum input power: 100 watts.

.5 Polarization: Vertical.

.6 Front-to-back ratio: 806 - 960 ≥ 18 dB, 1710 - 2200 ≥ 20 dB.

.7 Impedance: 50 Ω.

.8 Azimuth Pattern: As proposed by manufacturer to meet performance specifications in this Section.

.2 Mechanical:

.1 Radome material: UV-protected ABS.

.2 Pigtail cable: RG58, plenum rated.

.3 Connector: 50 Ω N Type Female.

.4 Mounting: Pole.

.3 700 MHz LMR Yagi Donor Antennas:

.1 Electrical:

.1 Frequency band, 746 - 806 MHz.

.2 VSWR ≤ 1.5:1.

.3 Gain: ≥ 1 1.1 dBi.

.4 Maximum input power: 100 watts.

.5 Polarization: Vertical.

.6 Front-to-back ratio: ≥ 15 dB.

.7 Impedance: 50 Ω.

.8 Beamwidth, Horizontal, degrees: 60.

.9 Azimuth Pattern: As proposed by manufacturer to meet performance specifications in this Section.

.2 Mechanical:

.1 Connector: 50 Ω N Type Female.

.2 Mounting: Pole.

.4 Omni-Directional Coverage: Omni-Directional Coverage antennas to feature a multi-band design, accommodating multiple frequency bands in a single small antenna.

.1 Electrical Band 1:

.1 Frequency Band: 698 - 800 MHz.

.2 VSWR: ≤ 1.8:1.

.3 Gain: ≥ 1.5 dBi.

.4 Maximum input power: 50 Watts

.5 Impedance: 50 Ω.

.6 Beamwidth, Horizontal: 360° omnidirectional.

.7 Beamwidth, Vertical: 80° nominal.

.8 Return Loss: 10.9 dB.

.2 Electrical Band 2:

.1 Frequency Band: 1710 - 2700 MHz and 800 - 960 MHz.

.2 VSWR: ≤ 1.5:1.

.3 Gain: ≥ 1.5 dBi @ 800-960 MHz and ≥ 5.0 dBi @ 1710 - 2700 MHz.

.4 Maximum input power: 50 Watts.

.5 Impedance: 50 Ω.

.6 Beamwidth, Horizontal: 360° omnidirectional.

.7 Beamwidth, Vertical: 65° nominal.

.8 Return Loss: ≤ 13.9 dB.

.3 Mechanical:

.1 Connector: 50 Ω N Type Female.

.2 Mounting: Thru-hole ceiling mount.

.3 Radome material: ABS, UV resistant.

.4 Pigtail cable: KSR195, plenum rated.

.5 Directional Coverage Antennas: Directional coverage antennas to feature a multi-band design, accommodating multiple frequency bands in a single small antenna.

.1 Electrical Band 1:

.1 Frequency Band: 698 - 800 MHz.

.2 VSWR: ≤ 1.8:1.

.3 Gain: ≥ 5.0 dBi @ 698 - 800 MHz.

.4 Maximum input power: 50 Watts.

.5 Impedance: 50 Ω.

.6 Beamwidth, Horizontal: 110° nominal.

.7 Polarization: Vertical.

.8 Return Loss: ≤ 10.9 dB.

.2 Electrical Band 2:

.1 Frequency Band: 1710 - 2700 MHz and 800 - 960 MHz

.2 VSWR: ≤ 1.5:1

.3 Gain: ≥ 5.0 dBi @ 800 - 960 MHz and ≥ 6.0 dBi @ 2170 - 2700 MHz and ≥ 8.0 dBi @ 1710 - 2170 MHz.

.4 Maximum input power: 50 Watts.

.5 Impedance: 50 Ω.

.6 Beamwidth, Horizontal: 90° nominal.

.7 Return Loss: ≤ 13.9 dB.

.3 Mechanical:

.1 Connector: 50 Ω N Type Female.

.2 Mounting: 4-hole wall mounting plate.

.3 Radome material: ABS, UV resistant.

.4 Pigtail cable: RG58, plenum rated.

.6 Fibre-Optic Cable and Connectors:

.1 Cables to be six-strand or greater, designed for point-to-point applications as well as mid-span access, and provide a high-level of protection for optical fibre installed in interior building environments.

.2 Higher optical fibre count cables to utilize a sub-unitized design with color-coded subunits for easy identification.

.3 Single-mode optical fibres to be 8.3 µm and use standard coloured tight-buffered construction.

.4 single-mode optical fibre to be dispersion-unshifted optical fibre that meets ITU-T G.652c standards.

.5 Cable to provide optimum performance over entire wavelength range from 1260 to 1625 nanometers.

.6 Cable to support new and emerging applications that utilize extended E band, 1360 to 1460 nanometers.

.7 Cable to also support existing and legacy single-mode applications that traditionally operate in 1310 and 1550 nanometer regions.

.8 Cable to deliver a cost-effective upgrade path by expanding available wavelengths by 50 percent supporting 16 Channels of coarse wave division multiplexing (CWDM) on a single optical fibre and up to 400 Channels of dense wave division multiplexing (DWDM) on a single cable.

.9 Fire ratings: Riser, plenum, and/or LSZH.

.7 Fibre-Optic Pigtails:

.1 To maintain channel integrity, optical fibre patch cords and pigtails to be fabricated to meet performance parameters corresponding to optical fibre cable approved product type specified below. Patch cord and pigtail plug connectors to be equipped with boots, and to have same colours as related optical fibre backbone cables, unless specified or indicated otherwise. Optical fibre patch cords and pigtails to be available with following options as specified or indicated:

.1 Termination types: SC-APC.

.2 Connector/cable configuration: Simplex and duplex.

.3 Fire ratings: Riser, plenum and/or LSZH.

.4 Patch cord outside diameters: 1.6 millimeters (0.063 inches) and 3.0 millimeters (0.118 inches).

.5 Pigtails: Ruggedized and tight-buffered optical fibre-0.9 millimeters (0.035 inches) outside diameter.

.6 Lengths: As specified or required.

.8 Air Dielectric, Plenum Rated Cable:

.1 Material Characteristics:

.1 Jacket: Halogenated, Fire-Retardant.

.2 Outer Conductor Material: Corrugated Aluminum or Corrugated Copper.

.3 Inner Conductor Material: Copper-Clad Aluminum Wire.

.2 Electrical Characteristics:

.1 Impedance: 50 ± 2.0 Ω.

.2 Frequency Band: 1 - 8800 MHz.

.3 Peak Power Rating: ≥ 40.0 kW.

.3 Mechanical Characteristics:

.1 Diameter Over Jacket: ≤ .627 in.

.2 Minimum Bending Radius: ≤ 5 in.

.3 One Time Minimum Bending Radius: ≤ 3 in.

.4 Attenuation Characteristics:

Frequency (MHz)	Attenuation (dB/100 ft)
150	≤ 0.848

Frequency (MHz)	Attenuation (dB/100 ft)
450	≤ 1.53
800	≤ 2.105
2000	≤ 3.564

.9 Standard Conditions: VSWR 1.0, ambient temperature 20°C (68°F)

.10 Foam Dielectric Cable:

.1 Material Characteristics:

.1 Jacket: Non-halogenated, Fire-Retardant Polyolefin.

.2 Outer Conductor Material: Corrugated Copper.

.3 Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube.

.2 Electrical Characteristics:

.1 Impedance: 50 ± 1.0 Ω.

.2 Frequency Band: 1/2" Nominal: 1 - 8800 MHz, 7/8" Nominal: 1 - 5000 MHz.

.3 Peak Power Rating: ≥ 40.0 kW.

.3 Mechanical Characteristics:

.1 Diameter Over Jacket: 1/2" Nominal: ≤ .630 in, 7/8" Nominal: ≤ 1.1 in.

.2 Minimum Bending Radius: 1/2" Nominal: ≤ 5 in, 7/8" Nominal: ≤ 10 in.

.3 One Time Minimum Bending Radius: 1/2" Nominal: ≤ 2 in, 7/8" Nominal: ≤ 5 in.

.4 Attenuation Characteristics: 1/2" Nominal:

Frequency (MHz)	Attenuation (dB/100 ft)
150	≤ 0.815
450	≤ 1.447
800	≤ 1.968
2000	≤ 3.251

.11 Standard Conditions: VSWR 1.0, ambient temperature 20°C (68°F).

.1 Attenuation Characteristics: 7/8" Nominal:

Frequency (MHz)	Attenuation (dB/100 ft)
150	≤ 0.417
450	≤ .744
800	≤ 1.014
2000	≤ 1.683

.12 Standard Conditions: VSWR 1.0, ambient temperature 20°C (68°F).

.13 Splitters, Combiners, Couplers, Coax Jumpers and Connectors:

.1 Products as recommended by system manufacturer to suit specific applications.

.14 BDA: Modular design using digital filtering to mitigate interference and accommodate multiple services for PSNs and WSPs.

.1 Characteristics:

.1 Operating Temperature Range: -33°C to +50°C.

.2 Chassis: To be of modular design with ≥ 4 frequency bands per 19" chassis. Chassis to not exceed four Rack Units (RUs) in height.

.3 Filtering: Digital.

.4 Separate Control: Each RF amplifier to be capable of adjusting and controlling power levels for each WSP when multiple WSPs share a single amplifier.

.5 FCC Part 90.219 Type Classification: Class A narrowband for LMR/SMR/ESMR frequency bands.

.6 Alarming: To support both SNMP and SMS using wireless modem.

.7 Mounting Options: to support rack, wall and pole mounting.

.8 Frequency Bands Supported: 380 - 512 MHz LMR, 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1900 - 1950 MHz PCS.

.2 Compliance:

.1 With local governing authority having jurisdiction.

.15 Fibre-Optic Master Unit: Converts radio over coax to Radio-Over-Fibre (RoF) for distribution to Fibre-Optic Remote Units.

.1 Characteristics:

.1 Transmission Media: Single-mode fibre at 1310 nm.

.2 Operating Temperature Range: +5°C to +40°C.

.3 Impendence: 50 Ω.

.4 Chassis:

.1 To be of modular design capable of supporting ≥ 32 Remote Units per 19", 4 RU chassis.

.2 To support redundant power supplies.

.3 To have capability to remotely power Remote Units via composite fibre-optic cable.

.5 Automatic Gain Control (AGC): To provide AGC for optical loss compensation.

.6 Optical Budget: To support ≤ 3 dB optical budget (~3 km or 2 miles).

.7 Auxiliary Channel: To provide an input to support 400 to 2700 MHz for future expandability.

.8 Interlink: To support one fibre or two fibres bi-directional optical link for distances up to 20 km with a 10 dB optical budget.

.9 Remote Supervision:

.1 To support TCP/IP protocol, SNMPv2, FTP, HTTP, Telnet, and be fully compatible with general purpose SNMP managers.

.2 Remote access to be available via Point-to-Point Protocol (PPP), over circuit-switched/packet data and wired/wireless modems.

.3 Each Active device to be manageable via a Web GUI.

.4 Auto Mapping: Each board position to be automatically mapped during system turn-up.

.2 Frequency Bands Supported: 380 - 512 MHz LMR, 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1900 - 1950 MHz PCS and 2496 - 2690 MHz BRS/EBS.

.16 Fibre-Optic Remote Units: Converts RoF signal back to radio over coax, as well as provides filtering so that multiple frequency bands can reside over same passive cable and antenna infrastructure.

.1 Characteristics:

.1 Operating Temperature Range: +5°C to +40°C.

.2 Impendence: 50 Ω.

.3 Power Consumption: ≤ 105 watts, maximum.

.4 Output Power per Carrier at Antenna Port:

Technology/Band (MHz)	Single Carrier (dBm)
Analog 700	27
GSM 700	27
Analog 800 & 850	27
GSM 850 & 850	31
GSM 850 & 850 at band edges	29
iDEN 800 & 850	26
iDEN 800 & 850 at band edges	24
CDMA 800 & 850	29
CDMA 800 & 850 at band edges	27
Analog 900	29
iDEN 900	23
CDMA 1700	30
W-CDMA 1700	28
Analog 1900	31
GSM 1900	31
CDMA 1900	29
W-CDMA 1900	27

.5 MTBF (excluding external power supply): ≥ 160,000 hours.

.6 Physical: Remote Unit to consist of following:

.1 Ingress Protection: IP31 or equivalent;

.2 Frequency Bands supported: 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1850 - 1995 MHz PCS;

.3 Optical Port: 2xSC-APC connector (separated uplink/downlink);

.4 Antenna Port: Single 50 Ω N type female connector;

.5 Auxiliary Ports: Two SMA female for future add-on modules.

.7 Uplink Noise Figure:

.1 LMR 700, LMR 800, Cell850: ≤ 7.5 dB;

.2 LMR 700, LMR 800, Cell850 at band edges: ≤ 9.5 dB;

.3 LMR 900: ≤ 8.5 dB;

.4 AWS: ≤ 7.5 dB;

.5 PCS 1900 extended: ≤ 7.5 dB.

.17 Equipment Cabinets:

.1 Equipment cabinets as follows:

.1 sized to house standard 19" racked equipment;

.2 hinged locking door;

.3 sized to accommodate required head end equipment including power supplies and spare future 20% capacity.

2.3 **SITE SURVEY/RF STUDY**

.1 Perform full site survey and RF study as required to design and layout system to provide specified performance levels in areas throughout building.

Part 3 - Execution

3.1 **INSTALLATION**

.1 Obtain required training from manufacturer representative on any special installation procedures. Install products in accordance with manufacturer instructions to suit specific installation requirements.

.2 Coordinate details of services with end users and WSPs. Obtain required approvals.

.3 Prepare final design drawings with required locations of devices.

.4 Install system in accordance with Manufacturer instructions and final design drawings.

3.2 **TESTING, ADJUSTING, START-UP & VERIFICATION**

.1 Include for manufacturer technician to provide onsite after installation inspection, testing, adjusting, start-up, and verification of system.

.2 Document tests and results in report signed by test technician.

.3 Additionally, refer to testing, coordination and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

3.3 **SYSTEM TRAINING & INSTRUCTIONS**

.1 Provide training of Owner designated staff on principles of connections and operations to system. Clearly instruct on procedures of disconnections and reconnections to accommodate changes and relocations of connected equipment.

END OF SECTION

Part 1 - General

1.1 SUBMITTALS

.1 Submit shop drawings for products specified in this Section.

.2 Shop drawings shall be prepared by the manufacturer and comprise only originals of project specific drawings and data sheets. Photo copied catalogue sheets are not acceptable.

.3 Shop drawings for each component including main PA cabinet, administrative console, pre-amp, inter-com call stations, speakers, transformers, horns, microphone, digital switches, BIX blocks to connect existing PA wiring to switches, volume controls and wiring.

.4 Include a block diagram illustrating the manner in which the contractor intends to layout the system. Show wiring type, gauge as well as terminal connections/numbers.

1.2 EXISTING SYSTEM

.1 The existing Dukane MCS series PA system console, and pre-amp is to be removed and replaced. Existing school PA devices, clocks and associated wiring to be removed and replaced and connected to new PA system control components. (Refer to Section 26 00 10 Allowance).

1.3 SYSTEM VENDOR

.1 The contractor shall engage the services of Hamilton Video and Sound Ltd. (Andrew Braun 905-522-1200) to provide, install and commission the system shown on the drawings.

Part 2 - Products

2.1 PAGING AND PUBLIC ADDRESS SYSTEM - GENERAL

.1 **Scope of Work:**

.1 Electrical infrastructure work to be provided by electrical contractor to accommodate public address (PA) system and include but not limited to provision of following:

.1 Engage the services of Hamilton Video and Sound Ltd. (Andrew Braun 905-730- 8306) to provide, install and commission the system as shown on the drawings;

.2 rough-in conduit from each PA device to the corridor cable tray for PA wiring installation. Conduits shall be complete with nylon fish cord in any conduits 20 mm (3/4") diameter or less and 3 mm (1/8") nylon rope in any conduits larger than 20 mm (3/4") diameter;

.3 120 VAC duplex receptacle/power connection within 1m (3.3') of PA cabinet in Mechanical room 124;

.4 installation of wiring into conduits/raceways, as directed by PA system vendor; wiring to be supplied by PA system vendor;

.5 demolition and removal of the existing Dukane MCS PA console and associated non-compatible equipment as directed by the PA system vendor. Replacement of the equipment to be scheduled with the General Contractor and Owner to minimize disruption to the school year operations.

.6 Coordination of work with various trades and system vendors.

.2 PA system vendor to provide PA system and include, but not be limited to, provision of following:

.1 control equipment, amplifiers, mixers, equalizers, software, equipment cabinets, power supplies, switches and accessories required for a complete operating system to distribute audio throughout areas;

.2 system programming;

.3 final terminations of cabling system components;

.4 system installation, inspecting, set-up, adjusting, testing and verifying entire system including, speakers and interconnected equipment, as applicable.

.2 System to be integrated system with required CSA approvals, ULC listings and ESA inspection approvals, as required.

.3 System to provide paging on a zoned basis and all call throughout project areas and in selected zones. Zones to be confirmed with existing system and meet specific requirements of Owner. Allow for new zone for relocated Childcare area rooms. System supplier to provide detailed design of system to meet specific requirements of Owner and submit detailed drawings with shop drawing submission. Provide additional components to supplement specified components as required to provide a fully integrated system.

.4 System shall be based on a Carehawk CH1000 Life Safety Communications System, microprocessor based, single master intercom and sound distribution system.

2.2 PAGING AND PUBLIC ADDRESS SYSTEM COMPONENTS

.1 Control and amplification shall be provided by a wall mounted Carehawk CH1000 microprocessor based control cabinet complete with microphone inputs and three auxiliary inputs for compact disc player, AM/FM tuner or other stand alone device. Control cabinet shall be mounted in a Storage room in the Administration area.

.2 The control cabinet shall contain all power supplies to run the system, interface cards, control cards, audio/communication card, telephone communications card, digital amplifier and intercom card required for all call, selective zone calling and individual two way communications.

.3 Wall/ceiling mounted switching modules to provide audio/input ports for annunciation call-in and bi-directional communications with the display administration console.

.4 Administrative phone with following features:

.1 Control centre for paging, intercom, security, video and telephone communications with Carehawk CH1000 cabinet;

.2 Backlit LCD graphic display with 14 lines by 16 characters, (display turns red to indicate emergency communications);

.3 One-touch emergency page;

.4 9 custom speed dials;

.5 Visual and audible indicator for incoming calls;

.6 System status with real-time status line icons;

.7 Built-in speaker phone for hands-free VOX based communications;

.8 Independent volume control for handset, speaker and ring;

.9 Powered by CAT 5e or CAT 6 up to 1000 ft from CH1000 cabinet.

.10 Built-in diagnostics

.5 Paging Microphone**:** TOA model PM-660U

.6 Classroom PA/Intercom call station consisting of:

.1 Dual cone loudspeaker: McBride 8LS821-19
.2 Dual voltage transformer: McBride MCT7025
.3 Backbox (surface) McBride SMC20E
.4 Baffle: McBride MC25SQ
.5 Call switch: McBride MCSW-1

.7 Ceiling speaker consisting of:

.1 Dual cone loudspeaker: McBride 8LS821-19
.2 Ceiling backbox: McBride MC10E
.3 Ceiling baffle: McBride MC11
.4 Mounting channels for T-bar ceilings: McBride MC100
.5 Plaster ring: McBride RMC10

.8 Interior/Exterior Speaker Paging Horn: TOA "SC-615T" and accessories:

.1 Wireguard: McBride HC-1;

.9 Outdoor PA Bell: Edwards #340-10G5 and accessories:

.1 Flush mounted backbox: Edwards 513-1
.2 Flush mounted grille: Edwards 513-3

.10 Volume Control: McBride MCATT-10

.11 Wiring and Ancillary Devices:

.1 Wiring and ancillary devices to be provided to complete total installation of system in accordance with the equipment manufacturer requirements.
.2 Switch module 32 audio ports: Carehawk SS32
.3 Switch module 16 audio ports: Carehawk SS16
.4 Cable assembly (BIX to RJ45): Carehawk CBBIX

.12 System Start-up, Testing and Verification: Provide system start-up, testing, inspection and verification work.

.13 Instructions: Provide instruction on operating and maintenance of system.

Part 3 - Execution

3.1 **GENERAL PA INSTALLATION REQUIREMENTS**

.1 System vendor to review Contract Documents and submit as part of shop drawings:

.1 proposed equipment and system operation functionality;
.2 detailed design installation drawings, equipment layouts, wiring diagrams and associated design and installation documents;
.3 identify paging zones;
.4 identify typical design sound levels.

.2 Provide complete PA system fully installed, programmed, tested, verified and certified.

.3 Obtain required training from manufacturer’s representative on any special installation procedures. Install products in accordance with manufacturer’s instructions to suit specific installation requirements.

.4 Confirm wiring types and conduit and box requirements with system vendor and/or manufacturer. Verify exact conduit system configuration and routing on site.

.5 Typically install wiring in conduit or raceways. Where permitted by Owner and reviewed with Consultant, use "J" hooks in accessible ceiling spaces, to ensure proper installation of cables that are not installed in conduit or raceway systems. UTP structured cabling must follow TIA/EIA standard methodology as noted in TIA/EIA 568.

.6 Provide supervision and execution of installation of cabling for pulling tensions, quantities, types, lengths, routing cable, group separation, and identification.

.7 Review installation and location of outlets with Consultant. Install cover plates to outlets.

.8 Where ceiling tiles have been installed, be responsible for removal and re-installation of tiles. Tiles and grid members which have been marked or damaged during installation of this system to be replaced by this Contract. Verify conditions on site.

.9 Co-ordinate work of each vendor/trade on site.

.10 For installation of wiring and equipment ensure that following guidelines are met:

- .1 manufacturer’s recommended installation specifications for equipment and materials;
- .2 avoid sources of EMI (electro-magnetic interference);
- .3 maintain minimum of 125 mm (5") of separation from fluorescent lighting ballasts;
- .4 do not run data/voice/paging and power cables together in a shared conduit or pull box;
- .5 avoid sources of heat such as heating ducts and hot water pipes;
- .6 use proper cabling paths to improve cable management;
- .7 use same pin/pair assignments throughout entire system;
- .8 maintain pair twists as close as possible to point of mechanical termination;
- .9 never exceed a 90 degree bend radius for any cabling;
- .10 never tighten ties around cabling to a point where they are not able to be moved;
- .11 use appropriate professional methods for dressing and securing cables;
- .12 never allow cabling to rest on drop ceilings;
- .13 leave slack (minimum 450 mm [18"]) on each end of cable run in event of servicing or other requirements;
- .14 do not install microphone wiring in same conduit as speaker wiring;
- .15 make connections of 2 pair cable to multi conductor cable with approved crimp connectors;
- .16 do not splice wiring;
- .17 balance audio circuits to ground.

.11 Ground and bond system as required by local governing electrical code and authority and system manufacturer. Ground and bond equipment used in installation that has potential to conduct current, i.e. equipment racks, metallic pathways, and wall mount enclosures. Ground and bond each equipment rack.

.12 Identification:

- .1 Permanently identify cables, racks, terminal blocks, and junction ports at each cable end and component demarcation with information necessary for troubleshooting and in a manner approved by Owner and reviewed with Consultant. Labels to reflect home run wiring closet and termination port.
- .2 Label cables with room numbers.
- .3 Ensure that system cables are tested, certified, and labelled.

.13 Wiring Closet Layout:

.1 Termination equipment installation locations such as P.A. cabinet, telephone cabinet, BIX blocks, IDFs and other equipment to be installed as shown on drawings or as recommended by PA system vendor.

.14 Acceptance Testing

.1 Test cables for correct continuity and polarity and for shorts.

.2 Provide programming and adjusting of features and balancing of components to satisfaction of Owner and reviewed with Consultant.

.3 The PA system vendor shall test the system to ensure proper operation and make any changes or corrections to the system if any defects occur at no cost to the Owner;

.4 The contractor shall include in his Tender price, all costs required for the PA system vendor technicians visit and testing.

.5 Demonstrate operation of system including integrated auxiliary systems functionality to Owner and Consultant.

.15 Training:

.1 Perform on-site training of users (including provision of user guides) prior to cut-over and to attend at site week following cutover to ensure that Owner's staff are properly trained in operation of system. Training to consist of two full days of basic use, and detailed training on functional use of system.

.2 Perform on-site training Train up to 4 selected appointees in complete administration of system and of its component subsystems. Include also for in-house training on software operation of system to up to 4 designated Owner staff.

.16 Documentation:

.1 Provide manufacturer technical documentation indicating equipment specifications and hardware modules included in system to Owner. Provide complete warranty details for hardware and labour used in system.

3.2 INSTALLATION OF PA SYSTEM COMPONENTS

.1 Provide system components to serve areas for PA operations.

.2 Obtain required training from manufacturer representative on any special installation procedures. Install products in accordance with manufacturer's instructions to suit specific installation requirements.

.3 Install central control unit/paging console and remote microphones in locations as confirmed with Owner and reviewed with Consultant. Connect complete. Provide paging zones and system sequence of operation as confirmed with Owner and reviewed with Consultant prior to start of Work. Programme system to suit Owner requirements. Partition system such that zones may have different sources at same time.

.4 Coordinate paging zones with Owner and Childcare facility staff.

.5 Reconnect existing music source equipment to new PA system. Provide all new wiring in conduit raceway and cable tray. Connect sources to control equipment.

.6 Install microphone outlets, remote interconnect boxes and auxiliary devices where required. Secure each in wall mounted outlet boxes and connect complete. Review exact type of outlets with Consultant prior to ordering.

.7 Mount recessed speakers and enclosures recessed in ceiling structure in accordance with manufacturer recommendations and reviewed with Consultant. Secure speakers with suspension chains from ceiling slab. Do not support speaker assembly from suspended ceiling system.

.8 Mount surface speakers and enclosures on ceiling slabs/decks in accordance with manufacturer's recommendations and reviewed with Consultant.

.9 Confirm exact height and locations prior to roughing in. Coordinate mounting heights with installation of other adjacent devices.

.10 Exact ceiling/wall speaker locations and aiming to be co-ordinated on site with other ceiling/wall mounted devices and equipment. Site conditions and interferences to be reviewed by Consultant prior to roughing in work.

.11 Install devices in accordance with manufacturer recommendations and reviewed with Consultant. Secure speakers with suspension chains from ceiling slab. Do not support speaker assembly from suspended ceiling system.

.12 Install system wiring in conduit in accordance with certified "reviewed" wiring schematic shop drawings. Provide shielded cabling for applications recommended by system vendor and/or manufacturer. Ensure that wiring is in accordance with system supplier's recommendations and is colour coded and properly identified terminals.

.13 Provide integration work to auxiliary systems as specified in Part 2.

.14 Provide operating and maintenance instructions to Owner designated personnel.

3.3 TESTING AND VERIFICATION

.1 After completion of installation work, make arrangement with Consultant and Owner and PA system equipment supplier to have a final functional witness acceptance test, giving minimum 7 working days' notice to parties concerned to be present. Exact schedule of testing work must be approved in writing by Owner and reviewed with Consultant.

.2 Contractor to include in Tender price, all costs required for the PA system vendor's technician to program, test, adjust and verify system and provide minimum one hard copy and electronic copy of signed report of documented test results.

.3 Tests to include following:

- .1 check of devices to ensure proper connections and supervision;
- .2 operation of an initiating device on each circuit to verify required operation of alarm devices, annunciator and other installations;
- .3 testing of signal devices for correct operation and function;
- .4 testing of sequence of operation of system with integrated systems and equipment;
- .5 submission of detailed test report of system performance, signed by authorized testing technician;

.4 Additionally, refer to testing, coordination and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

END OF SECTION

Part 1 - General

1.1 SUBMITTALS

.1 Submit shop drawings for products specified in this Section.

1.2 SOFTWARE NOMENCLATURE REPROGRAMMING

.1 Include additional costs for system Manufacturer to make necessary on site final changes to applicable system/equipment software. Make such changes after successful testing and verification of the systems, but prior to turn over to Owner. After successful final verification of the work, confirm and obtain approval of final nomenclature in writing from Owner and Consultant. Software revisions to incorporate final room names/area names/building names and equipment identification.

1.3 SYSTEM SUPPLIER/INSTALLER QUALIFICATIONS

.1 System supplier/installer to be an established communications and electronics contractor that currently maintains locally run and operated business for at least 5 years and holds applicable provincial and local licenses.

.2 Supplier/installer to be valid authorized distributor for product/system proposed with full Manufacturer warranty privileges.

.3 Supplier/installer to employ technicians who have attended and successfully completed Manufacturer technical certification training for proposed system.

.4 Supplier/installer to show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to system. Supplier/installer to maintain at their facility, necessary spare parts in proper proportion as recommended by system manufacturer to maintain and service equipment being supplied.

Part 2 - Products

2.1 WASHROOM EMERGENCY CALL SYSTEMS

.1 Provide an emergency call system consisting of CSA approved and/or ULC listed components to provide system in compliance with local governing codes and standards, with following operations:

- .1 activated emergency call station in ADA designated washroom sends signal to un-attended central control unit that indicates that someone in washroom needs assistance; stations to be supervised; trouble signal to be sent to control unit in event of station failure, unless otherwise directed by Owner;
- .2 central control station includes head end equipment for system terminations and console for responding to communications device and circuitry to automatically dial and forward assistance calls and trouble signals to designated Owner monitoring station / response station;
- .3 activated emergency call station in ADA designated washroom sends signal to audible and visual devices that indicate that someone in washroom needs assistance;
- .4 audible devices and visual devices located over washroom door illuminate and sound tone when remote call stations are activated; visual and audible signals to be distinct and of different types of signals from other building systems;
- .5 call stations, audible devices and visual devices to only be reset when call has been responded to and activated station locally reset.

.2 Central control head end equipment is microprocessor based equipment with capacity for monitoring up to minimum 6 remote stations. Power supplies include battery back-up for entire system for minimum 60 minutes, or more where required by local governing authority. Console includes:

.1 annunciator with LCD display or individual LED lamps with nameplates identifying calling stations;

.2 non-volatile memory for calls and system events;

.3 lamp test push button, other required controls and power supplies;

.4 wall or desk mounting provisions as coordinated with Consultant to suit specific applications.

.3 Remote stations to be tamper-proof, vandal-proof and with call pushbutton of minimum 32 mm (1-1/2") dia., but of greater size if required by local governing codes. Stations include reset button, call tone and call assurance LED light. Stations to include user able reset feature. Call tone to have adjustable sound level.

.4 Remote stations to be tamper-proof, vandal-proof and with 1.8 m (6') long PVC call cord. Stations include reset button, call tone and call assurance LED light. Stations to include user able reset feature. Call tone to have adjustable sound level.

.5 Signage: engraved lamacoid emergency sign that contains wording - "IN EVENT OF EMERGENCY PUSH EMERGENCY BUTTON AND AUDIBLE AND VISUAL SIGNAL WILL ACTIVATE" in letters at least 25 mm (1") high with 5 mm (3/16") stroke and that is posted above call station. Exact sizing and nomenclature to be as per local governing code requirements and reviewed with Consultant prior to ordering.

.6 Visual devices to be flashing LED type with Lexan lens and audible signal tone, mounted onto single gang stainless steel faceplate, and suitable for mounting onto recessed electrical box. Signals to be distinct from other building systems. Confirm LED colour with Consultant prior to ordering.

.7 Subject to approval of local governing inspection authority, interior audible and visual signals may be devices remote from call station but still within room and also must meet performance requirements specified herein. Flush mount in recessed boxes.

.8 Provide power supplies, wiring and mounting hardware as required and as recommended by system manufacturer.

.9 Wiring to be of type in accordance with applicable local governing codes and standards, and as recommended by system vendor.

.10 Provide system to suit application as shown and as required. Ensure that stations meet requirements of each application as recommended by manufacturer. Include required accessories to suit. Provide weatherproof and corrosion resistant devices for devices located in non-climate controlled areas.

.11 Verify system sequence of operation with local governing authority inspector and coordinated with Consultant.

.12 Manufacturer authorized vendor to supply, install, test, start-up and certify complete systems as required.

.13 Acceptable manufacturers are:

.1 GE (Chubb Edwards);

.2 Aiphone;

.3 TOA;

.4 Telecor;

.5 Rauland;

.6 Mircom;

.7 Jeron.

Part 3 - Execution

3.1 **INSTALLATION OF WASHROOM EMERGENCY CALL SYSTEM**

.1 Provide specified emergency call systems components and connect complete. Program sequence of operation as required and confirmed with Owner and Consultant. Exact programming requirements to be verified with local governing authority and coordinated with Consultant and/or Owner.

.2 Obtain required training from Manufacturer representative on any special installation procedures.

.3 Install head end central equipment central console in location as confirmed with Consultant. Connect complete with required power and communications wiring. Review mounting requirements with Consultant.

.4 Install devices in locations as coordinated with Consultant prior to roughing-in. Install components at mounting heights as noted on drawings and confirmed with Consultant. Generally, mount devices on recessed back boxes. Typically locate audible/visual devices above doorframe. Locate power supplies in service room accessible location confirmed with Consultant.

.5 Set sound level of interior audible devices at level acceptable to Owner and coordinated with Consultant. Adjust as required.

.6 Provide required system wiring. Wiring to be copper conductor, colour coded, and in accordance with system Manufacturer recommendations and instructions. Connect equipment in accordance with system Manufacturer certified wiring diagrams and instructions and under direct supervision of manufacturer. Run conductors in conduit.

.7 Install devices and perform work in accordance with Manufacturer instructions and requirements and in accordance to applicable codes of local governing bodies having jurisdiction.

.8 Confirm locations of devices prior to roughing-in.

.9 Provide a lamacoid identification nameplate for each enclosure. Confirm wording of identification nameplates and colour finishes of devices with Owner prior to ordering.

.10 Install signage as required. Locate in position and secure to wall with proper mechanical fasteners. Confirm exact nomenclature, sizing and locations with Consultant with shop drawing submissions.

.11 Coordinate installation of signage with General Contractor.

.12 After installation is complete, test, adjust and verify operation of system. Demonstrate system operation and maintenance with Owner staff.

.13 Obtain approvals from local governing inspection authorities.

3.2 **TESTING & VERIFICATION OF SYSTEM**

.1 After completion of installation work, make arrangement with Consultant and Owner and manufacturer of equipment to have a final functional witness acceptance test, giving minimum 7 working days' notice to each party concerned to be present. Exact schedule of testing work to be approved in writing by Consultant.

.2 Include minimally the following:

.1 check of devices to ensure proper connections and supervision;

.2 operation of an initiating device on each circuit to verify required operation of alarm devices, annunciator and other installations;

.3 testing of signal devices for correct operation and function;

.4 testing of each secured door access control components and review of events reported at head end;

.5 testing of sequence of operation of system with integrated systems and equipment;

.6 start-up procedures;

.7 submission of detailed test report of system performance, signed by authorized testing technician.

.3 Include for system Manufacturer authorized technician to this work and provide minimum one hard copy and electronic copy of signed report of the documented test results.

.4 Additionally, refer to testing, coordination and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

3.3 **TRAINING**

.1 Manufacturer trained technician to perform onsite training of each user (including the provision of user guides) prior to project completion to ensure that users are properly trained in the operation and maintenances of system.

.2 Refer to Instructions to Owner specified in Section titled Common Work Results for Electrical.

END OF SECTION

Part 1 - General

1.1 SUBMITTALS

.1 Submit shop drawings for products specified in this Section.

1.2 SOFTWARE NOMENCLATURE REPROGRAMMING

.1 Include additional costs for system manufacturer to make necessary on site final changes to applicable system/equipment software. Make such changes after successful testing and verification of systems, but prior to turn over to Owner. After successful final verification of work, confirm and obtain approval of final nomenclature in writing from Owner and Consultant. Software revisions to incorporate final room names/area names/building names and equipment identification.

1.3 SYSTEM SUPPLIER/INSTALLER QUALIFICATIONS

.1 Supplier/installer of system to be an established communications and electronics contractor that has and currently maintains a locally run and operated business for at least 5 years and holds applicable provincial and local licenses.

.2 Supplier/installer to be a valid authorized distributor for product/system proposed with full manufacturers warranty privileges.

.3 Supplier/installer to employ technicians who have attended and successfully completed manufacturers technical certification training for proposed system.

.4 Supplier/installer to show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to system. Supplier/installer to maintain at their facility necessary spare parts in proper proportion as recommended by system manufacturer to maintain and service equipment being supplied.

Part 2 - Products

2.1 MASTER WIRELESS GPS CLOCK SYSTEMS

.1 Primex Wireless, GPS (Global Positioning System) type wireless system that continually synchronizes clocks throughout facility using GPS technology to provide atomic time. Features include:

- .1 clock readouts in multiple time zones;
- .2 automatic adjustment for Daylight Savings Time;
- .3 analogue clocks synchronized to within 10 milliseconds 6 times per day;
- .4 internal oscillator maintains plus or minus one second per day between synchronizations, so clock accuracy does not exceed plus or minus 0.2 seconds;
- .5 internal clock reference so that failure of GPS signal does not cause clocks to fail in indicating time;
- .6 fail-safe design so that failure of any component does not cause failure of system; upon restoration of power or repair of failed component, system to resume normal operation without need of resetting system or any component thereof;
- .7 clocks are portable;
- .8 system operates in accordance with a "Technical Acceptance Certificate" issued by Industry Canada and Ministry of Industry; license granted to and held by end user (Owner).

.2 System manufacturer to make payments and to provide required documents and technical information to Industry Canada and other governing local authorities, for approval.

.3 Include for provision of following:

.1 XR series, 5/30 watt master transmitters with GPS receiver/ antennae, rack, surge protector, UPS back-up system;

.2 XR series, 5/30 watt master transmitters with NTP interface, rack, surge protector, UPS back-up system;

.3 satellite transmitters with receiver switch, rack, surge protector, UPS back-up system;

.4 external outdoor antennae;

.5 exterior weatherproof coaxial antennae cabling; antennae/receiver cable to be provided in length to suit installation location on rooftop;

.6 standard round, 317 mm (12.5") satellite clocks with 12/24 hour display and complete with long life maintenance free batteries, high impact polycarbonate frame and lens, and clock lock; face to include Owner logo; exact clock dial face, logo and finish to be confirmed with and approved by Consultant prior to ordering; optional 120 VAC power supply operation; synchronized from master or satellite transmitter;

.7 digital time clocks: 63 mm (2.5") x 6 digit, 7 segment LED display with user configurable alternating time and date; 12 or 24 hour display, 120 Vac power supply; synchronized from master or satellite transmitter; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim;

.8 digital time clocks with elapsed timer; clocks: 63 mm (2.5") x 6 digit, 7 segment LED display unit of hours, minutes and seconds, that start and stop with push of a button and counts up or down until stopped; logs of elapsed time events including duration of event, time of day and date are sent to server and are available for retrieval by authorized users; 12 or 24 hour display, count up or count down timer; power outage memory back-up for up to 8 hours; 120 Vac power supply; synchronized from master or satellite transmitter; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim;

.9 Code Blue Timer: 65 mm (2.5") x 6 digit, 7 segment LED display unit of hours, minutes and seconds, to indicate elapsed time during Code Blue event that integrates with Code Blue system and also operates through remote control unit; logs of elapsed time events including duration of event, time of day and date are sent to server and are available for retrieval by authorized users; 12 or 24 hour display, count up or count down timer; power outage memory back-up for up to 8 hours; 120 Vac power supply; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim; remote switch control allows user to run, hold or reset timer and consists of 3 pushbuttons mounted on stainless steel faceplate complete with required interconnection cable and connectors;

.10 clock lock feature;

.11 protective wireguards;

.12 mounting hardware and ancillary devices as required for full installation;

.13 system wiring as per system manufacturers requirements;

.14 system software programme;

.15 Industry Canada licence.

.4 Engage system manufacturer to review documents prior to submission of pricing before close of Bids. Ensure that equipment selection proposed meets requirements of Work and that signal strength and clock coverage areas are adequate to give proper system performance throughout.

.5 Final selection of clocks to be as directed by Owner at a later date.

.6 Manufacturers representative to provide following on site work:

.1 programme system head end;

.2 inspect installation;

.3 adjust, test, start-up and certify system;

.4 instructions on system operating and maintenance.

.7 Base Bid manufacturer/supplier is Primex Wireless Canada (1-800-330-1459). Other manufacturers may be accepted subject to following (submit proof with shop drawings):

.1 that system features and performance at least match base specified system;

.2 systems are CSA approved and ULC listed and labelled, as applicable;

.3 system has been installed and operating in other Canadian facilities for at least past three (3) years;

.4 system products and parts are stocked and serviced by a Canadian distributor/vendor within Province of install.

2.2 MASTER WIRELESS NETWORK CLOCK SYSTEMS

.1 Primex Wireless, SNS (Synchronous Network System) type wireless system that continually synchronizes and automates management of clocks throughout facility using 802.11 wireless network.

.2 System features wireless network connected clocks with network time protocol (NTP) synchronization, data collection, data backup, and user access from anywhere in world. SNS clocks are synchronized by signals from network Gateway SNS Applications Management Platform (AMP) server over an 802.11b/g wireless network or 10/100 Base T Ethernet system. Time signals originate from local Network Time Protocol (NTP) server, keeping clocks in synch with time shown on network computers.

.3 SNS clock incorporates automated monitoring, alerting, and reporting firmware. Clock firmware performs diagnostics on battery life, time accuracy, and strength of wireless connection, and sends this data to AMP Gateway server. SNS AMP Gateway server also receives and stores event logs showing time and date records from Elapsed Timers. These logs, backed up on central server, are available to authorized users on AMP and can be e-mailed to assigned staff.

.4 System operates over building WIFI system. Clocks are controlled from signals transmitted over WIFI system or through wired network cabling to local RJ45 jacks. Coordinate work with structured network cabling work section.

.5 Additional system features include:

.1 clock readouts in multiple time zones;

.2 automatic adjustment for Daylight Savings Time;

.3 clocks continue to indicate accurate time within plus or minus 0.35 seconds in 24 hours;

.4 internal clock reference so that failure of NTP system signal does not cause clocks to fail in indicating time;

.5 fail-safe design so that failure of any component does not cause failure of system; upon restoration of power or repair of failed component, system to resume normal operation without need of resetting system or any component thereof;

.6 clocks are portable;

.7 system operates in accordance with a "Technical Acceptance Certificate" issued by Industry Canada and Ministry of Industry; license granted to and held by end user (Owner).

.6 System manufacturer to make payments and to provide required documents and technical information to Industry Canada and other governing local authorities, for approval.

.7 Include for but not be limited to provision of following:

.1 SNS applications management platform system software;

.2 round, 317 mm (12.5") SNS clocks with 12/24 hour display and complete with long life maintenance free batteries, high impact polycarbonate frame and lens, and clock lock; face to include Owner logo; exact clock dial face, logo and finish to be confirmed with and approved by Consultant prior to ordering; optional PoE or 120 VAC power supply operation; synchronized from master or satellite transmitter;

.3 SNS digital time clocks: 63 mm (2.5") x 6 digit, 7 segment LED display with user configurable alternating time and date; 12 or 24 hour display, 120 VAC power supply; synchronized from wired Ethernet connection or wireless WiFi; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim; optional PoE powered;

.4 SNS digital time clocks with elapsed timer; clocks: 63 mm (2.5") x 6 digit, 7 segment LED display unit that start and stop with push of a button and counts up or down until stopped; logs of elapsed time events including duration of event, time of day and date are sent to server and are available for retrieval by authorized users; 12 or 24 hour display, count up or count down timer; power outage memory back-up for up to 8 hours; 120 Vac power supply; synchronized from wired Ethernet connection or wireless WiFi; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim;

.5 SNS Code Blue Timer: 63 mm (2.5") x 6 digit, 7 segment LED display unit to indicate elapsed time during Code Blue event that integrates with Code Blue system and also operates through remote control unit; logs of elapsed time events including duration of event, time of day and date are sent to server and are available for retrieval by authorized users; 12 or 24 hour display, count up or count down timer; power outage memory back-up for up to 8 hours; 120 Vac power supply; flush or surface mounted; complete with mounting bracket for surface mounting; flush trim; remote switch control allows user to run, hold or reset timer and consists of 3 pushbuttons mounted on stainless steel faceplate complete with required interconnection cable and connectors;

.6 clock lock feature;

.7 protective wireguards;

.8 mounting hardware and ancillary devices as required for full installation and integration to network system (include programming of transmitter and system devices as required);

.9 system wiring as per system manufacturers requirements;

.10 gateway server: standard 19-inch-wide single rack unit that synchronizes clocks over network with signals from NTP server, stores and forwards system information from clocks;

.11 Industry Canada licence;

.12 SNS temperature sensor;

.13 SNS humidity sensor;

.14 SNS vibration sensor;

.15 synchronous crash car kit.

.8 Engage system manufacturer to review documents prior to submission of pricing before close of Bids. Ensure that equipment selection proposed meets requirements of Work and that signal strength and clock coverage areas are adequate to give proper system performance throughout.

.9 Final selection of clocks will be as directed by Owner at a later date.

.10 Manufacturers representative to provide following on site work:

.1 programme system head end;

.2 inspect installation;

.3 adjust, test, start-up and certify system;

.4 instructions on system operating and maintenance.

.11 Base Bid manufacturer/supplier is Primex Wireless Canada (1-800-330-1459). Other manufacturers may be accepted subject to following (submit proof with shop drawings):

.1 that system features and performance at least match base specified system;

.2 systems are CSA approved and ULC listed and labelled, as applicable;

.3 system has been installed and operating in other Canadian facilities for at least past three (3) years;

.4 system products and parts are stocked and serviced by a Canadian distributor/vendor within Province of install.

2.3 MASTER WIRED CLOCK SYSTEM

.1 SimplexGrinnell, CSA approved Series 6400 series system with clocks and controls as specified in paragraphs which follow. Note that series numbers may be obsolete. Confirm updated series with manufacturer and provide approved equivalent series.

.2 General 6400 series time control centre shall include:

.1 six (6) programmable microprocessor program control circuits, 4 program schedules; system software programme;

.2 LCD display;

.3 7 day battery standby;

.4 automatic daylight savings adjustment;

.5 manual override switches;

.6 impulse clock control;

.7 interface to external synchronization via RS232;

.8 clock load relays as required.

.3 SimplexGrinnell, CSA approved, analogue, synchronous wired clocks as follows:

.1 300 mm (12") round;

.2 face, hands and numbers to be confirmed by Owner during shop drawing submission;

.3 integral nickel cadmium battery backup;

.4 moulded high impact ABS case (confirm exact finish with Architect);

.5 protective wire guards;

.6 protective ABS acrylic guards;

.7 flush mounting backbox with semi-flush mounting kit;

.8 120 VAC operation;

.9 system wiring as per manufacturers requirements.

.4 SimplexGrinnell, CSA approved, 2301, "Celestra" direct-read, digital, synchronous wired clocks as follows:

.1 illuminated 50 mm (2") high LCD;

.2 integral nickel cadmium battery backup;

.3 line amplifiers as required;

.4 moulded high impact ABS case (confirm exact finish with Architect);

.5 protective wire guards;

.6 protective ABS acrylic guards;

.7 flush mounting backbox with semi-flush mounting kit;

.8 low voltage operation, as required to suit system requirements;

.9 system wiring as per manufacturers requirements.

.5 Provide manufacturers supplied and recommended suitable power and hanging receptacle that is integrated with backbox to allow for recessed wall mounting of clocks.

.6 Manufacturers representative to provide following on site work:

.1 programme system head end;

.2 inspect installation;

.3 adjust, test, start-up and certify system.

.7 Acceptable manufacturers are:

.1 SimplexGrinnell;

.2 Chubb Edwards;

.3 Siemens;

.4 Dukane;

.5 Rauland.

2.4 BATTERY OPERATED STANDARD CLOCKS

.1 GE model 24A716, ULC listed and labelled, 300 mm (12”) round faced, battery operated standard clocks as follows:

.1 stand alone, analogue type with quartz movement;

.2 surface mounting;

.3 12/24 hour display;

.4 black minute and hour hands and red seconds hand;

.5 high impact polycarbonate housing;

.6 polycarbonate lens;

.7 wire guard where noted;

.8 alkaline batteries.

.2 Acceptable manufacturers/vendors:

.1 SimplexGrinnell;

.2 GE/Chubb Edwards;

.3 Rauland;

.4 Siemens.

Part 3 - Execution

3.1 **INSTALLATION OF MASTER WIRELESS CLOCK SYSTEM**

.1 Provide specified master clock system. Include for and arrange for system manufacturers authorized representative to program system and to integrate to other low voltage systems. Connect complete. Provide wiring in conduit and/or in cable trays where noted. Provide suitable recessed backboxes for mounting of clocks.

.2 Obtain required training from manufacturers representative on any special installation procedures. Install devices and perform work in accordance with the manufacturers instructions and requirements and in accordance to applicable codes of the governing authorities having jurisdiction.

.3 Size transmitters and of quantity to provide coverage of areas throughout complex, as per manufacturers recommendations.

.4 Locate clocks in coverage areas of wireless access points to ensure WiFi signal is available for proper synchronization and operation of clocks.

.5 Perform a site coverage test to ensure proper operation of clocks in locations as shown and in areas where future clocks may be added. Adjust, relocate, and/or add to system as required to provide full coverage of building.

.6 Provide 120 VAC power circuits to clocks requiring such power. Digital clocks with timers require 120 VAC power as confirmed with manufacturer.

.7 Install remote control units of digital clock timers, in recessed wall boxes. Connect to clock units with required wiring in conduit.

.8 Coordinate location of GPS antennae installation with Consultant to suit exterior architectural aspects of building. Obtain Consultants approval of location and routing of cabling prior to roughing in.

.9 Coordinate network connections to Owners LAN with Owners IT Department. Install software onto server and programme to suit project requirements and Owners directions.

.10 Coordinate RJ45 outlet and structured cabling requirements with vendor responsible for providing structured network cabling system. Install telecom jack at each clock outlet and extend telecom UTP cabling back to LAN equipment serving area. Refer to section regarding structured network cabling for product and installation requirements.

.11 Confirm exact clock requirements with Consultant prior to ordering.

.12 Confirm locations of clocks and equipment with Consultant prior to roughing-in.

.13 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

.14 Provide onsite system inspection, testing, adjusting, start-up, and verification as specified in Part 1.

.15 Demonstrate operation to Owner and Consultant.

.16 Refer to drawings for system riser diagram and locations of equipment.

3.2 **INSTALLATION OF MASTER WIRED CLOCK SYSTEM**

.1 Provide specified clocks and controller and install devices in accordance with manufacturers requirements. Programme system to suit Owners requirements.

.2 Install clocks on mounting hanger type receptacles and connect complete. Provide wiring in conduit.

.3 Confirm exact locations of devices and finishes with Consultant prior to roughing-in.

.4 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

.5 Provide onsite system inspection, testing, adjusting, start-up, and verification as specified in Part 1.

.6 Demonstrate operation to Owner and Consultant.

.7 Refer to drawings for system riser diagram and locations of equipment.

3.3 INSTALLATION OF BATTERY OPERATED STANDARD CLOCKS

.1 Install clocks in accordance with manufacturers instructions to suit application.

.2 Provide backbox suitable for wall installation.

.3 Confirm clock face 12 or 24 hour display requirements and finishes with Consultant prior to ordering.

.4 Check and test operation.

END OF SECTION

Part 1 - General

1.1 GENERAL PURPOSE

.1 To establish the technical, functional, jurisdictional, or regulatory and quality requirements for security and access control systems; which are required to be purchased from vendors. Approved technical specifications define the supply and installations of all security and access control systems and identify approved manufacturers and models.

.2 The security system shall consist of implementing an integrated networked Access Control and Video Assessment System (ACAMVAS) that shall control personnel access, provide real time intrusion detection alarm monitoring and provide alarm driven video surveillance for the designated buildings and operations in accordance with the requirements and specifications prescribed in these documents and the approved drawings. The security system shall include the following, where applicable:

.3 Seamless integration of a digital video management system that will allow system operators to control and maintain the security of the facilities from multiple designated client workstations.

.4 Seamless integration of video surveillance systems that provides alarm driven assessment for the intrusion detection equipment at designated facilities.

.5 Seamless integration with wireless networked locksets from Assa Abloy or Salto to provide doors with a battery powered solution for access control without the need to pull multiple wiring cables to the door.

.6 Commissioning and testing of the systems and equipment installed as required to meet manufacturers' specifications and documented installation procedures, and to the satisfaction of the Owner.

.7 Training of the Owner's personnel to: fully operate, and perform routine maintenance on the systems and equipment installed.

.8 Provide all associated documentation for the security system upgrades.

1.2 REFERENCE STANDARDS

.1 Underwriters' Laboratories of Canada (ULC)

.2 American National Standards Institute (ANSI) Standards

.3 Ontario Building Code

.4 CANASA (Canadian Alarm and Security Association)

.5 CFAA (Canadian Fire Alarm Association)

.6 All products comply with the Canadian certifications listed above.

1.3 QUALITY ASSURANCE

.1 System supply, installation and support shall be carried out by one of the following pre-qualified authorized re-sellers.

.1 M&R Security Inc.
Address: 46-16 Regan Road, Brampton, ON L7A 1C1
Contact: Amy Martinez
Email: amy@mnrsecurity.ca
Phone: (905) 216-6424

.2 V.S.I. Inc.
Address: 2650 Meadowvale Blvd, Unit #3, Mississauga, On L5N 6M5
Contact: Len Todaro
Email: lentodaro@vistasecurity.co
Phone: (905) 858-8211

.3 Vipond
Address: 6380 Vipond Road, Mississauga, On L5T 1A1
Contact: Don Connor
Email: don.connor@vipond.ca
Phone: (416) 458-1990

.4 SSN networks Inc.
Address: #24, 1295 Eglinton Avenue East, Mississauga, On L4W 3E6
Contact: Ashish Kaushal
Email: ashish.kaushal@ssnnetworks.com
Phone: (647) 300-9194

.5 Capital Fire and Security Inc.
Address: 52-665 Millway Avenue Unit 52, Concord, On L4K 3T8
Contact: Dino Abballe
Email: dino@capitalfireandsecurity.ca
Phone: (905) 660-0007

.6 Colossus Security Inc.
Address: 55-3176 Ridgeway Drive, Mississauga, On L5L 1K7
Contact: Jarrod Budd
Email: jbudd@colossussecurity.com
Phone: (888) 204-8833

Part 2 - Products

2.1 **SECURITY COMPONENTS**

.1 Listed below are the security components that shall be supplied and installed. A detailed specification of each of the security components included in this list is also included.

2.2 **ACCESS CONTROL AND ALARM MONITORING SYSTEM**

.1 General System Specifications: The access control and alarm monitoring system shall be the RBH Access Technologies AxiomV Enterprise system and meets the following design and performance specifications:

.1 The system shall be a modular, networked access control and alarm monitoring system, comprised of proven commercial off the shelf components, capable of handling large proprietary corporations with multiple remote sites, alarm monitoring, video imaging, badging, paging integration, CCTV integration, interactive guard tour, mapping, visitor management, email notification, third party monitoring, BAS integration and asset management. The system shall assure long time performance, cost effective upgrade capability and allow for easy expansion or modification of inputs, outputs and remote control stations.

.2 The system control at the central computer location shall be under a single software program control, shall provide full integration of all components, and shall be alterable at any time, depending upon the requirements. Reconfiguration shall be accomplished online through system programming, without hardware changes.

.3 The Access Control Software system shall utilize Microsoft SQL Server 2008/2012/2016 for data storage and be written expressly for Microsoft SQL Server 2008/2012/2016.

.4 The system shall have the capability to be networked via a LAN/WAN connection utilizing industry standard TCP/IP communication protocol. The system shall provide encryption via the TCP/IP connection

.5 The system shall incorporate the use of bi-directional 485 communications and/or Class "A" TCP/IP redundant connections for redundancy and reliability.

.6 The system shall incorporate "High Availability" Communications so that multiple communication paths are available to all controllers. High availability shall be defined as, "an existing alternate controller shall take over communications in the event the main controller fails. The controller must be located in a separate location to the first."

.7 The system shall support both manual and automatic responses to alarms entering the system. Each alarm shall be capable of initiating a number of different actions, such as camera switching, activation of remote devices and door control.

.8 The system shall provide unlimited levels of emergency codes to allow the system to operate in different security levels depending on local threat level e.g. code black = bomb threat and building locks down.

.9 The system shall provide both supervised and non-supervised alarm point monitoring. Upon recognition of an alarm, the system shall be capable of switching CCTV cameras and automatically creating a popup window for video for the associated alarm. The system shall be capable of arming or disarming alarm points both manually and automatically, by time of day, and by day of week.

.10 Access control functions shall include validation based on time of day, day of week, holiday scheduling, site code verification, automatic or manual retrieval of card/tagholder photographs, and access validation based on positive verification of card/tag, card/tag/PIN, card/tag and video.

.11 The system programming shall be user friendly, and capable of being accomplished by personnel with no prior computer experience. The programming shall be menu driven and include online "Help" with the use of F1 hotkey to automatically call the proper help information to the screen. The software shall utilize drop boxes for all previously entered system required data.

.12 After installation, the Owner shall be able to perform basic hardware configuration changes. These hardware configuration changes shall include, but not be limited to, door open time, door contact shunt time, point and reader names, when and where a card/tagholder is valid, and the ability to add or modify card/tag databases as desired without the services of the Manufacturer or Manufacturers Dealer.

.13 Equipment repair shall be able to be accomplished on site, by module replacement, utilizing spare components. All equipment shall have pluggable connectors for easy replacement.

.14 All control components shall include the ability to download operating parameters to any control panel, thus allowing the control panel to provide full operating functions independent of any other system component.

.15 The system shall be designed in such a way that it does not require enrolment of authorized personnel at each building.

.16 The system shall provide seamless integration to multiple manufacturers of DVR's and NVR's at the same time.

.17 The system shall provide seamless integration with external building control systems (BAS), personal safety systems, remote paging and email systems.

.18 All system events, operator actions and maintenance information shall be stored on the computer hard disk to maintain a permanent record of system activity. The system shall have the capability for manual and automatic back-up of set-up and system events to either local removable media (optical/magnetic) or remote network resource.

.19 All workstations shall be configurable to act as Alarm monitoring centre for the system. All alarms shall be configurable by schedule and workstations will have the ability to acknowledge and clear alarms as a two step process.

.20 All workstations shall have the ability to define alarm routing with an unlimited number of Routing levels available to the system.

.2 Interactive Mapping and Graphics: The system shall support an unlimited number of user programmable colour graphic map displays capable of showing the floor plan, location of alarm device, and alarm instructions. Floor plans shall be created in an approved format and shall be capable of being imported from other systems. All of the graphic maps shall be displayed on the CPU monitor. Systems requiring separate display monitors or PC's shall not be acceptable. Maps shall be interactive with dynamic real-time status so that the operator can control all device functions from the map.

.3 Information Storage: All programmed information as well as transactional history shall be automatically stored onto the hard disk for later retrieval.

.4 Information Backup/Retrieval: The CPU shall be capable of transferring all programmed data and transactional history to thumb drive or any logical disk drive. All programmed data shall be restorable from disk in case of system hardware failure.

.5 Communication Rates: The system shall have bi-directional communications and communicate up to 2.5mb/s.

.6 Printers: The system shall support all system printers configured under and supported by the Windows operating system.

.7 Pointing Device: The system shall use the pointing device configured under and supported by the Windows operating system.

.8 Communication Ports: The system shall support and unlimited number of either serial or TCP/IP ports.

.9 Workstations: The system shall support an unlimited number of active remote workstations. These stations shall be capable of monitoring alarms and changing the database and retrieving transaction records in real time without affecting the other stations.

.10 Networking: The system shall operate with the standard Windows networking software.

.11 Database: The database shall be Microsoft SQL Server 2008/2012/2016.

.12 Software Capacities:

.1 The System server shall have the following minimum requirements. Server 2008/2012, Windows 7, 8.1 and 10 pro, with 2.2 GHz clock speed, 2gig Ram, 40 gig hard drive, CD Rom, Pointing device and video graphics card with 512 on board ram.

.2 System software and language development software shall be existing, industry accepted, and of a type widely used in commercial systems. The solutions operating system requirements shall be as identified in 2.2.3. The application software shall have been written in a standard, industry accepted language. All System functions shall be accessible via Windows operating systems compliant menu accessed screens. Systems requiring command string control or complex syntax shall not be acceptable. Systems shall not be dependent upon external input other than keyboard.

.3 The system software shall include the following features and be configured as a minimum:

.1 Unlimited reader expansion
.2 Unlimited card/tagholders in software
.3 Unlimited simultaneous client PCs
.4 Unlimited time zones
.5 365 user-definable holidays
.6 Unlimited Access levels
.7 Access levels for each card/tagholder
.8 Unlimited alarm input points
.9 Unlimited output control points
.10 Unlimited operator passwords with definable privilege levels
.11 Audible alarm annunciation at the CPU
.12 Unlimited colour graphic maps displayed on the CPU monitor
.13 TCP/IP or RS232 interface capability to a CCTV system, which provides automatic, alarm actuated camera switching.
.14 True 32/64 bit operation
.15 Operator activation/cancellation dates
.16 Employee activation/cancellation dates
.17 Optional Video Imaging/Badging & bar code imprinting

.13 System Administrators shall have the following abilities as a minimum:

.1 To change any station settings from whatever station they are working on.
.2 To establish Station Names. Station names shall be user-definable.
.3 The Station Status dialog shall be available. It shall display a list of stations and their on line/offline status, along with the names of the logged-on operators.
.4 Report Printers: Reports as requested by the operators are sent to printers that may reside anywhere on the network.

.14 Alarm Window Description: The system shall facilitate the processing of alerts by using a pop-up alarm window. The Window shall list the system alarms and allow the operator to acknowledge and clear by right-clicking on the event. The alarm window shall indicate time of alarm and response time by the operator. The alarm shall incorporate programmable instruction messages to instruct the operator what he is to do. The alarm will also have an operator action window to log an action into history for the alarm.

.15 Bulk Acknowledgment of Alarms: The system shall provide a means to bulk-acknowledge alarms, so that all alarms can be acknowledged with a single operator action.

.16 Station Routing: The system shall support the routing of alarms to any or all stations. Time schedules can be used to determine which station an alarm is routed to at what time. An alarm may be routed to one station or group of stations during a time schedule and re-routed to another station or group of stations during another time schedule.

.17 Operator Routing: The system shall support the routing of alarms to particular operators, regardless of which station the operator is logged onto.

.18 Menu Configurations: The system software shall allow for the configuration and programming of the controller panel through the use of a simple graphical user interface (GUI). All devices and functions shall be right click configurable for easy operation.

.19 Memory: memory within each controller panel shall be automatically configured by the system.

.20 Database Updates: The system software shall download/upload information to the controller panels automatically while the controller panels are in communication with the host CPU. A data download may also be initiated manually.

.21 Reporting: The system software shall have the capability to report selectable data by type and by time zone. The system software shall allow the user to generate a report to screen, to printer or to save to a file. The reports shall be exportable to over 30 different file formats. The system shall incorporate the use of an automatic report generator.

.22 Workstations: The system software shall have the capability to report selectable data by type and by time zone to any combination of the system workstations simultaneously.

.23 Serial Ports: All serial ports shall be configured from an easy to follow menu. Systems requiring in depth knowledge of the operating system or CMOS setup for port configuration shall not be acceptable.

.24 Time Zones:

.1 The system software shall have the capacity for a minimum of 255 user-definable time zones. Each time zone shall allow for a minimum of 16 individual time intervals.

.2 The time zones shall be assignable to:

.1 Card/tagholders

.2 Outputs

.3 Alarming reporting functions

.4 TCP/IP and RS232 message ports

.5 Doors

.6 Reports

.7 Printer operation

.8 Workstations

.25 Holidays: The system software shall support a minimum of 365 holidays. Holidays shall be considered HI or H2 designation so that there are three distinct holiday times. A holiday shall be capable of starting at any time/hour during a 24-hour day. Systems requiring holiday start time of midnight shall not be acceptable.

.26 Door Descriptions: Each door in the system shall be identified using logical tagging format and approved by the Owner. Each door description shall be assigned user-definable text of up to 50 characters.

.27 Access Control Modes: Each door may be programmed to switch automatically based on a user defined time schedule between the following modes of operation:

.1 "CARD/TAG ONLY"

.2 "CARD/TAG + PIN" - Dual authentication shall be provided for access points requiring the user to use their credential and enter a four digit PIN number.

.3 "PIN ONLY" - Keypad readers shall be used at doors to prevent access by Alzheimer residents.

.4 "HIGH SECURITY"

.5 "TWO PERSON" - To add additional security two people must be required to present cards (or any other credentials) in order to access a secure area.

.6 "FREE ACCESS"

.28 Duress: If the reader is operating in the "CARD/TAG + PIN" mode or "PIN ONLY" mode, a duress feature shall allow an alternate code to be entered into the keypad for access. The system shall generate an alert and may be linked to control relays for notification of the alarm.

.29 Door Alarms: Each door may be programmed to generate "FORCED DOOR" and "DOOR HELD OPEN" alarms. These alarms shall have the ability to have a user-definable time delay.

.30 Door Alarm Annunciation: In addition to generating an alarm message, the following conditions may activate an output for annunciation:

.1 FORCED DOOR
.2 DURESS
.3 DOOR HELD OPEN (DOOR AJAR)
.4 VOID CARD/TAG
.5 DENIED CARD/TAG
.6 ANTI-PASSBACK VIOLATION
.7 INPUT DOOR ALARM
.8 TAMPER
.9 ALARMS

.31 Alarm Description: Each alarm point may be defined with a plain text description of up to 50 characters.

.32 Alarm Enabling: Alarm points shall be enabled during user-definable time zones and may be manually enabled/disabled from any workstation.

.33 Additional Alarms: The system must also generate alarms for the following:

.1 Enclosure tampering
.2 Controller panel communication loss
.3 Channel 1 Fail /Channel 2 Fail
.4 Battery Failure
.5 AC Failure
.6 Reader Fuse
.7 Auxiliary Fuse
.8 Lock Fuse
.9 Alarm tampering (supervised)

.34 Alarm Supervision: When using supervised alarm points, the system must monitor for "OPEN", "SHORT", in addition to "NORMAL/ABNORMAL" conditions.

.35 ASCII Output: Alarm points shall output an ASCII via RS232 or TCP/IP text command for integration to any other IP commandable device. This command/output shall be an optional, user-definable and transmitted on alarm points going into abnormal state, returning to a normal state, or both.

.36 Outputs:

.1 Shunt relays: User definable outputs may be assigned as shunt relays, allowing access doors to be monitored by third party alarm systems.
.2 Relay "on" time: Outputs assigned to control doors shall be user-definable from 1-127 seconds or minutes.

.37 Encryption: the passwords shall be encrypted in the operator database using encryption, to facilitate confidentiality of individual operator passwords.

.38 Operator Access Levels: The system shall provide unlimited operator access levels for the system. All operator actions will be recorded within the system database.

.39 Password Security: The Operator password shall be encrypted to prevent operators from seeing passwords. Passwords shall be up to 20 alphanumeric characters and be case sensitive. Operators must have the right to edit their own password for secrecy.

.40 Partitioning: The System shall incorporate true database partitioning by operator. An operator shall logon anywhere on the system and have the same functionality at any workstation. Operators will be limited to see and control of the system by their operator Access level.

.41 Operator Access Levels: The system shall have the ability to define unlimited user roles. As a minimum, the user roles shall be:

- .1 General Administrator
- .2 Supervisor
- .3 General User
- .4 Privilege levels shall be assignable to, but not limited to the following menu functions:
  - .1 View
  - .2 Edit
  - .3 Edit of any field within the menu
  - .4 Select

.42 Operator Activity: All operator activity including specific changes to the database shall be stored for later retrieval and Operators shall be assigned a time zone for the purpose of logging in.

.43 Audit Trail of Database Changes:

- .1 The system shall record changes to the database, including the date, time, operator name and description of the record changed.
- .2 The audit trail event messages shall record additions, deletions and revisions. The record shall contain a date/time stamp for the change, the logged on operator's name, the table name, a character identifying the change, and a description based upon the Name field from the record, such as the user name, operator name, panel name, reader/door name.
- .3 The system shall do a full restore or partial depending on operator selection of the data or history files during the back-up process.
- .4 The system shall allow for viewing of the audit trail.
- .5 The system shall NOT allow The Audit Trail table to be edited.

.44 Employee Definitions:

- .1 Card Entering: Card entering shall be easy so that minimal training is required. Card input and changes shall be allowed through direct interface with the event viewer screen. Cards shall have the ability to have multiple access levels or assigned special access levels. Cards may be inactivated from the system while the data remains for reactivation at a later date.
- .2 Card/tag Data: The system software shall allow for card/tag numbers up to 18 digits.
- .3 Employee records: Employee records shall consist of a minimum of the following:
  - .1 Card/tag Number
  - .2 Issue level

.3 Two (2) groups of access level and time zone
.4 User-definable PIN code
.5 Facility code
.6 Anti-passback location and status
.7 Expiration date
.8 High Security
.9 Lock/Unlock privilege
.10 Code Links
.11 Track status
.12 Last door accessed
.13 22 user definable searchable text and data fields
.14 Duration use
.15 Escort
.16 Extended shunt (for ADA compliance)
.17 Passback override

.4 Batch Loading: The system software shall allow groups of card/tags to be input through the use of a card/tag number range or by a batch load employee field.

.45 Reports

.1 Data Storage: All programmed and transactional history is automatically stored to the hard disk for later retrieval.

.2 System Function: The system software shall be capable of generating reports without affecting the real-time operation of the system.

.3 Media: Reports shall be generated from the hard disk, or removable media and exportable to over 30 file formats.

.4 Search Criteria: The database shall be structured such that the operator shall determine the search parameters based on variables available on the individual report menu. Systems requiring the user to type complicated search strings shall not be acceptable.

.5 Report Types: User-definable data reports shall be available for the following information:

.1 Card/tagholder data
.2 Door groups
.3 Time zones
.4 Doors
.5 Inputs
.6 Relays
.7 Links
.8 Controller panels
.9 Operators
.10 System hardware configuration
.11 System settings configuration

.6 Transaction Reports: Transaction reports shall be available for the following:

.1 Card/tag transactions
.2 Alarm transactions
.3 Event transactions
.4 Operator activity

.5 Time and Attendance

.7 Report Scheduling: The system software shall have the ability to batch reports to any of: screen report, report to a network printer or save a report to a file without operator initiation.

.46 System Guides:

.1 On Line Help: The system software shall have on line help available at any point requiring operator input. The help screen shall be accessible by using the standard Windows help systems. These help screens shall contain context sensitive information that shall allow the operator to enter correct data without consulting the manual. The help menu shall be accessible to the exact point in software by using the "F1" hotkey.

.47 System Status:

.1 Real Time Status: The operator shall be able to monitor via graphical screens, the status of the following in real time:

.1 Inputs

.2 Outputs

.3 Doors

.2 Alarm Monitor: A screen shall be available to monitor alarms and view, at minimum, 99 of the most recent events. The operator shall also have the ability to view additional detail of any event through the use of a single keystroke or click of the mouse.

.48 Graphics:

.1 Graphics File Format: The floor plans shall be configured in AutoCAD, JPEG or Bitmaps.

.2 Programming: The system software shall be able to import floor plans produced in AutoCAD.

.3 Operation: Upon activation of a selected input or door alarm the map shall pop-up and display the alarmed device with an alarmed icon. The operator shall be able to click on the map and clear the alarm or control the device from the graphical interface. Mapping shall be real-time and interactive.

.49 Video Badging:

.1 The system shall have the capability to permit Video Imaging and Badging, which shall, when used in conjunction with the system software, function as an integrated Video Imaging/Badging and access control system. The system shall utilize a single PC to input data for both access and video Badging. The system shall not require the operator to enter data more than once. Badge information including name, card/tag number, signature, fingerprint, user text, bar coding and up to five data fields shall be available for each card/tag. The system shall provide for user definable backgrounds. These backgrounds may be a "captured" image or a colour background. The system shall be capable of supporting Windows 2000/XPPRO/WIN7PRO compliant video printers.

.2 Badges may be created in both horizontal and vertical configurations. In order to change a card/tagholder's badge, a new background may be selected from the background table. A new picture capture is not required. The system shall allow any input or reader to be programmed such that an event at that location is captured by a remote camera and displayed while being stored in the database for later viewing or printing. Events at the reader shall display in real time and store a "split screen" showing the stored card/tagholder image next to the "captured" image. Camera control shall be accomplished via an RS232 interface from the system to a video switcher. The programming of the camera switcher for the individual inputs and readers shall not require exiting from the access control program.

.3 Additional Badging and/or alarm PC stations may be added via a local area network (LAN).

.50 Video Imaging

.1 The system shall have the capability to import images of employees and store them in the database. These images may be recalled and displayed by the operator.

.1 The system shall have the ability to capture pictures and save from IP Video Cameras.

.2 The system shall provide for the backing up and restoral of captured pictures.

.51 DVR and NVR Integration:

.1 The system shall be able to integrate seamlessly via TCP/IP to multiple manufacturers DVR's and NVR's simultaneously. The operator shall have the option to associate any camera with a device and through a common video window, control, and operate any device with real time viewing. Video shall be accessible from any device via a right mouse click.

.2 Video history of any event shall be accessible via a right mouse click.

.3 The video window shall automatically pop-up upon activation of the associated device's alarm. Video shall be common to all manufacturers systems so that the operator only sees one view.

.4 Non-proprietary servers shall be used with provision for fail-over and redundancy.

.5 VMS shall be available in multiple languages including French.

.6 The VMS (video management software) shall be compatible to ONVIF compliant cameras and many other IP cameras.

.52 Interactive Guard tour: The system shall incorporate an interactive guard tour module to provide real time status of the Guards progression. Failure to complete a tour shall activate alarms on site and off-site for life safety operations.

.53 Asset Management: The system shall incorporate an asset management module so that owners are assigned to equipment or vehicles to prevent theft. Upon alarm the system shall notify via alarm, CCTV interface, and email status the improper event.

.54 System Tools:

.1 Copy Wizard -The system shall provide a copy wizard to quickly copy any device parameter to any other single or group of devices.

.2 Back-up Scheduler- The system shall have a backup scheduler for automatic backup of data

.3 Custom Cardholder fields - The system shall have the ability to custom design the cardholder data by adding new fields at will.

.55 Biometric/Fingerprint Enrollment: The software shall have an integrated tab in the cardholder screen to enable the operator to enroll fingerprints/ biometrics directly from the software. Programs that open third party software are unacceptable.

2.3 **HARDWARE - AXIOMV CONTROLLER PANELS**

.1 UNC500 TCP/IP CONTROLLER

.1 The controller panel shall be a 32 bit microprocessor controlled solid-state electronic device and shall include a real time clock/calendar on board. Boards shall be made of gold plated construction (Copper or leaded will not be accepted) and incorporate flashware technology. Communication shall Two channel TCP/IP standard LAN/WAN windows environment protocol. A subset of the system database sufficient to support access and alarm functions for its designated readers and points shall be stored at the controller panel. In event of communication loss, the controller panel shall continue to function without degradation of operation and shall provide storage of a least 10,000 events. These stored events shall be uploaded to the CPU automatically upon restoration of the communications. The system shall be capable of performing all system functions indefinitely without the computer.

.2 The controller must be FCC, CE, RoHS and UL listed.

.3 The controller must have 8mb Ram available on board

.4 The controller must have 65,000 offline event buffer

.5 The controller must have 3 programmable RS485 ports

.6 The controller must have 2 on board Wiegand reader ports to accept any Wiegand format and 5 Wiegand formats simultaneously.

.7 The controller must have 8 fully supervised inputs capable of individual configuration for EOL (single and dual EOL), N.O, N.C. operation.

.8 The controller must have 8 outputs. 4-form 'C' relay outputs rated at 10A-30VDC and 4-open collector 100ma outputs.

.9 The controller must have two on board TCP/IP LAN connections capable of configuration in LAN switch mode or dual LAN operation for Class 'A' Communication configurations.

.10 The Controller must have separate tamper input

.11 Input voltage 12vdc or 30w P.O.E. maximum current draw 500ma

.12 The controller must have internal charging circuit for 12vdc gel cell standby battery. The controller shall be capable of recharging a standby battery from either P.O.E. source or 12v local power supply.

.13 The controller shall be configurable in the following methods. Edge device, Wall mount controller or Rackmount.

.14 Edge device deployment shall be POE and operate continuously even if POE is lost. Edge controller shall operate 1 or 2 doors as desired.

.15 Rackmount configuration shall be 2 UNC500 controllers or 4 doors in a standard 1U-19inch rack configuration. LAN connections shall be front facing as standard Network configuration. All device connections shall be independent and removable from the rear of rack for quick disconnect and easy troubleshooting. All rackmount cabinets shall have optional rails for slide out configuration. All rackmount cabinets shall have top removable panel to access control panels.

.16 The controller when configured in switch mode shall allow LAN looping from one standard windows device to another as any standard network switch allows without the use of external switches or special LAN cabling.

.17 The controller must accept and control up to 7 slave reader controllers and 16 I/O controllers simultaneously.

.18 Links are defined as any action causing any reaction on the system. Each controller shall be capable of initiating 'Links' regardless of the computer status.

.19 Readers shall have the ability to initiate s swipe and or 4 swipe commands based on user card programming to initiate a different sequence of events depending on the need.

.20 The controller panel shall be capable of storing up to eight (25) custom card/tagcard/tag/tag formats and reading 5 formats simultaneously. The controller panel shall be able to read the format of most Magnetic Stripe, Bar Code, Proximity or Wiegand Effect encoded card/tagcard/tag/tags and shall allow an operator to specify parity, start sentinels, stop sentinels, field separators, facility code bits, issue level bits, and card/tagcard/tag/tag number bits.

.21 The controller panel shall be capable of reading card/tag numbers up to eighteen (18) digits.

.22 The controller panel shall have the capacity to store up to 128 time zones with each time zone consisting of up to 16 intervals of time. Each interval of time shall consist of a range of days (seven days of the week, in addition to a Holiday Schedule) as well as a range of time. The controller panel shall automatically manage time zones based upon its internal clock.

.23 The controller panel shall allow for the definition of up to 365 Holidays. Holidays shall be defined according to day of year and time of day. All holidays shall be automatically incorporated into Time Zone definitions.

.24 Each card/tag reader/keypad shall have the ability to independently operate in up to six different modes: Card/tag reader only, PIN only, Common Code only, Card/tag Reader plus PIN, High Security and Free Access. These modes of operation shall be programmed from the system host computer and shall automatically change by time zone assignment.

.25 The system shall support interlock groups for Man -trap operation.

.26 The controller panel shall allow for the support of anti-passback operation, in which card/tagholders must follow a proper in/out sequence.

.2 UNC100 CONTROLLER

.1 The controller panel shall be a 32 bit microprocessor controlled solid-state electronic device and shall include a real time clock/calendar on board. Boards shall be made of gold-plated construction (Copper or leaded will not be accepted) and incorporate flashware technology. Communication shall One channel TCP/IP standard LAN/WAN windows environment protocol. A subset of the system database sufficient to support access and alarm functions for its designated readers and points shall be stored at the controller panel. In event of communication loss, the controller panel shall continue to function without degradation of operation and shall provide storage of a least 10,000 events. These stored events shall be uploaded to the CPU automatically upon restoration of the communications. The system shall be capable of performing all system functions indefinitely without the computer.

.2 The controller must be FCC, CE, RoHS and UL listed.

.3 The controller must have 2mb Ram available on board

.4 The controller must have 50,000 offline event buffer

.5 The controller must have 1 programmable RS485 ports

.6 The controller must have 2 on board Wiegand reader ports to accept any Wiegand format and 5 Wiegand formats simultaneously.

.7 The controller must have 4 fully supervised inputs capable of individual configuration for EOL (single and dual EOL), N.O, N.C. operation.

.8 The controller must have 4 outputs. 2-form 'C' relay outputs rated at 10A-30VDC and 2-open collector 100ma outputs.

.9 The Controller must have separate tamper input

.10 Input voltage 12vdc or 30w P.O.E. maximum current draw 500ma

.11 The controller must have internal charging circuit for 12vdc gel cell standby battery. The controller shall be capable of recharging a standby battery from either P.O.E. source or 12v local power supply.

.12 The controller shall be configurable in the following methods. Edge device, Wall mount controller.

.13 Edge device deployment shall be POE and operate continuously even if POE is lost. Edge controller shall operate 1 or 2 doors as desired.

.14 The controller must accept and control up to 7 slave reader controllers and 16 I/O controllers simultaneously.

.3 RBH-IOC-16 Input Output Controller

.1 Additional inputs and outputs shall be available by adding IO boards. Each expansion board shall have a minimum of sixteen (16) supervised inputs or outputs. The inputs shall incorporate full supervision of 7 circuit types and the outputs shall be form "C". Up to sixteen (16) expansion boards shall be available for each controller panel.

.2 The IO board shall be independently powered and have its own back up power supply and charging circuit for a minimum 4 hour standby operation.

.4 RBH- ENCL2 Wall Cabinets :

.1 The controller panel enclosure shall have a hinged cover with key lock. A control panel input point shall monitor an enclosure tamper switch.

.2 The cabinet shall be 22" X 18" X 4" with ½ and ¾ inch knockouts. The back of the cabinet shall have key mounts for easy mounting.

.3 The cabinet shall hold any two of the following controllers UNC500, NC100, RC2, IOC16

.5 NC100 Controller Panel Firmware Features

.1 The controller panel shall have the ability to store up to 7000 card/tagcard/tag/tag/pin codes expandable to 500,000 and buffer up to 10,000 transactions expandable to 500,000.

.6 CARD/TAG READERS & CARD/TAGS

.1 The system shall employ a proximity access control/identification technology that utilizes radio frequency (RF) circuits in microchip form. The microchips are encoded and transmit the encoded information when activated.

.2 The readers shall be any Wiegand output or equivalent proximity/iclass/mifare type. It shall read the identification number of the card/tag or tag when presented to the surface of the reader without physical contact.

.3 Single piece window/door frame reader, which shall mount directly on a standard 1.75" (4.5cm) metal mullion/door frame. The reader can be mounted indoors or outdoors on virtually any surface, including metal. The reader shall operate between 5 volts and 14 volts DC to allow for ease and flexibility in installation. Read range with a standard proximity card/tag shall be up to 4" (up to 10cm) when installed according to manufacturer's specifications. Maximum dimensions of the reader shall be 5.5" (14.0cm) High x 1.6" (4.1cm) Wide x 0.75" (1.9cm) Thick.

.4 A single piece wall switch reader, which shall mount directly on a standard metal or plastic single-gang electrical box, or on a flat wall or metal surface, and shall operate indoors or outdoors. The reader shall operate between 5 volts and 14 volts DC to allow for ease and flexibility in installation. Read range with a standard proximity card/tag shall be up to 4" (10cm) when installed according to the manufacturer's specifications. Maximum dimensions of the reader shall be 4.6" (11.7cm) High x 2.9" (7.6cm) wide x 0.5" (1.3cm) Thick.

.5 A single piece reader, which shall mount to any surface, including metal, or can be concealed behind most building materials, except metal. Read range with a standard proximity card/tag shall be up to 7" (17cm) when installed according to manufacturer's specifications. Maximum dimensions of the reader shall be 4.6" (11.7cm) High x 5.5" (14cm) Wide x 1.4" (3.6cm) Thick.

.6 A medium range reader, which shall mount to most surfaces, except directly on metal, or can be concealed behind most building materials, except metal. Read range with a standard proximity card/tag shall be up to 21" (42cm) when installed according to manufacturer's specifications. Maximum dimensions of the reader head shall be 8.8" (22.4cm) High x 8.8" (22.4cm) Wide x 1.14" (2.9cm) Thick.

.7 The card/tag or tag shall be read when presented in any orientation or at any angle to the surface of the reader within the proper read range

.8 The reader shall power the card/tag or tag, process the encoded data, and output the data to the access system in less than 110 milliseconds.

.9 There shall be no removable plate or cover, which allows access to the reader electronics.

.10 A red/green LED on the front surface of the reader shall indicate to the user that the card/tag or tag was read (internal/reader controlled) and an access decision was made (system controlled). The LED may be configured in either single line mode or dual line mode (allowing an "off" state) as required by the host system, and the reader may be switched between modes by presenting a programming card/tag to the face of the reader.

.11 The reader shall have an audio "beep" tone feature to indicate to the user that the card/tag or tag was read (internal/reader controlled) and an access decision was made (system controlled). The audio tone must be independently controllable and not tied to the status or colour of the LED. The internal control of the LED and beeper may be enabled/disabled via programming card/tags so as not to require the setting of switches internal to the reader.

.12 The reader shall have a built-in diagnostics, which indicate to the installer that upon power up the reader has performed an internal test and is functioning properly.

.13 The reader shall have a built-in diagnostic feature, which allows a single technician to test the continuity of the data lines independent of the door controller. The reader may be placed into the line diagnostic mode via a programming card/tag, and the technician can then measure the pulses at the end of the line without the need of a second technician at the reader presenting card/tags.

.14 Electrical connections between the reader and the controller shall be via colour coded, multiconductor; #22 AWG shielded cable. No coaxial cable or special connectors shall be required. The output shall be in the form of Wiegand data stream.

.15 Wiring from the reader assembly to the system interface or CPU shall be run inside metal conduit or EMT, as may be required by electrical codes. All junction boxes are to be concealed and bot normally accessible to the public. Utilization of PVC conduit is not acceptable.

.16 Accidental or intentional transmission of radio frequency signals into the reader shall not compromise the system.

.17 The reader shall function in the access control system's normal or anti-passback mode without changes to the reader.

.18 The reader operating temperature range shall be -40° to +50° C

.19 Damage or vandalism to the reader shall not damage any other part of the system.

.20 Tampering with the reader shall have no effect on the door security.

.21 The system readers shall have the capability to accept codes from any of the following proximity devices:

.1 A standard molded plastic credit card/tag sized card/tag having maximum dimensions of 3.41" (8.7cm) x 2.14" (5.4cm) x 0.09" (0.23cm), and a weight of not more than 0.48 oz. (13.5g). A punched slot shall be provided for a strap or clip. The card/tag shall be capable of having multi-colour custom graphics and permanently marked numbers printed directly onto both sides.

.2 A tag having maximum dimensions of 2.2" (5.6cm) x 1.3" (3.3cm) x 0.25" (0.6cm), and weight of 0.36 oz. (9.9g). A brass eyelet shall be provided for attachment to a key ring.

.3 A credit card/tag sized card/tag made of PVC, having maximum thickness of .036", and the capability of accepting direct print video imaged graphics and photographs and able to carry a high coercivity magnetic stripe.

.4 A credit card/tag sized card/tag having maximum thickness of .048", and capable of accepting a photograph and graphics via a customer laminated flap.

.22 The card/tag shall be a polycarbonate-based card/tag that cannot be run through direct card/tag printers. The card/tag shall be a PVC dual technology card/tag that employs proximity sensor technology. It shall comply with ISO standards for thickness (30 mil).

.23 The card/tag or tag shall be made of robust ABS plastic to provide maximum protection for the circuitry inside and provide minimal flexing which could cause damage to the card/tag.

.24 The presence of small metal objects, such as keys or coins near the card/tag or tag shall not alter the code read by the reader, nor prevent the code from being read by the reader.

.25 The card/tag shall be of a proprietary format to be controlled by the Owner.

.26 Card/tags or tags shall be sequentially numbered. The user may specify codes or numbers.

.27 The card/tag must have the ability to have the encoded number permanently marked on the outside surface.

.28 The card/tag or tag shall be a passive device with no internal battery, but shall contain a semiconductor element, which is energized when brought within the operating range of the reader causing transmission of the code from the card/tag or tag to the reader. Card/tags requiring an internal battery or energy cell shall not be acceptable.

.29 Card/tags and tags may be used interchangeably and shall be compatible with all readers in the system, regardless of the reader's physical size or style, and without any code matching or memory devices in the reader.

.30 The card/tag and tag operating temperature range shall be -40° to +50° C

2.4 **ACS VMS INTEGRATION**

.1 Integration must be through TCP/IP (relay and or RS232 connections are not acceptable).

.2 All devices within the ACS system must have a tab to associate a video camera from the VMS system to the device. This association must allow the camera to be called into the ACS GUI upon the following conditions. A) Any Incoming event from specified device B) Any incoming alarm from the specified device. The camera if PTZ must also be called to its pre-designation preposition.

.3 The ACS must be able to connect to the VMS system and display the VMS's default video window as a native VMS viewing client.

.4 The ACS must have the ability to pop-up any video event designated for pop-up without operator intervention.

.5 The ACS must have the ability to manually call video by clicking on the event anywhere it appears in the ACS.

.6 The ACS must have the ability to dynamically place the cameras from the VMS system on its maps and call video from the maps directly.

.7 The ACS must have the ability to report all events tagged with video and play back directly from the report within the ACS GUI.

2.5 **ALARM KEYPADS**

.1 The system shall incorporate alarm keypads that link directly to the system for advanced alarm operation. Operators can arm, disarm, send messages and monitor any alarm on the keypad. In addition the keypads shall have entry exit zones and the ability to initiate commands on the system by entering a code or command. The keypads will have the ability to arm or disarm any group of inputs on the system creating a seamless alarm intrusion panel.

2.6 **ALARM MONITORING INTEGRATION**

.1 The system shall allow for annunciation of intrusion detection alarms. Intrusion detection alarms shall report just like any other access control alarm and shall have the same annunciation and display properties as access control alarms.

.2 Alarms from the alarm keypad shall be displayed in the alarm monitoring window and any signal can be sent out via TCP/IP or message port.

.3 The system shall support an Alarm Details description that shall show the 'Alarm Description', 'Time/date', 'Controller', 'Device', and 'Area' associated with the alarm. The information shall also display the user.

.4 The system shall support tracing of intrusion detection devices and areas.

.5 The system shall be able to report status information for the intrusion detection devices.

.6 On alarm, the system shall automatically switch to the map that displays the alarm, the icon that represents that alarm point will flash and an audible alert will be generated on the computer sound system. The operator shall have to acknowledge the alarm before processing the alarm.

.7 In operator alarm mode processing, the system shall allow the operator to:

.1 clear alarm, tamper, and diagnostic alarms

.2 observe CCTV camera views, individually or in groups, that are associated with an alarm (requires video switcher option)

.3 In operator normal mode processing, the system shall allow an operator to:

.4 view a list of activity information, and select and tag any event

.5 view site maps

.6 perform a test of testable devices/sensors

.7 change the state of sensors to access or secure

.8 review the last 1000 events/actions performed on the system

.8 In maintenance processing, the system shall allow the maintenance technician to:

.1 assign passwords and function access to individual users

.2 examine the input/output point states

.3 adjust the sensitivity of the sensors

.4 access the operating system to diagnose system problems

.5 set the calendar clock's date and time (in Windows)

.6 change the format of the displayed date (in Windows)

.7 set the communication parameters for system devices

.8 shut down the system

2.7 WIRELESS LOCKSET INTEGRATION

.1 The system shall support the integration of SALTO SALLIS wireless locksets with the security management system. The wireless system and components shall offer as a minimum:

.1 Wireless Radio Frequency based on IEEE 802.15.4 at 2.4 GHz.

.2 Wireless communication shall incorporate AES 128bits encryption.

.3 Reading time shall be less than 150 milliseconds.

.4 Card reader ID technologies for the locks shall be able to read one of these: Mifare, Mifare plus, DESfire, DESfire EV1, HID iClass.

.5 Powering by standard non-proprietary, commercially available batteries. Renewal of batteries shall only be permissible from the secure side of any door with access to the battery compartment only achievable by the use of non-commercially available tool sets provided exclusively by the manufacturer.

.6 All electronic locking devices must be able to be temporarily activated by an appropriate device in the event of total battery failure.

.7 The access control system shall have a comprehensive battery management reporting system to allow for the viewing of the battery status of any locking device in the system at any time.

.8 The locking devices themselves shall provide, upon activation by a credential or other means, a distinguishable and audible signal when any battery is reduced to its last 1,000 usable cycles.

.9 The system shall support more than 500 remote locksets; each UNC100 controller configuration shall be rated for the number of locksets it can support.

.10 Once a lockset is installed and registered with the controller, it shall appear in the AxiomV software as a traditional access point, which can be enabled and configured to work with the controller.

.11 When a wireless lockset is networked to the AxiomV software, the operator shall be able to lock or unlock in real-time, the lock, under 2 seconds.

.12 All locksets connected to the AxiomV software shall be treated as an online lockset and assigned the Default (Online) lockset profile.

.13 Locksets can be assigned to locations.

.14 Locksets shall be added and managed in floorplans.

.15 Locksets can be unlocked momentarily via event actions or from the AxiomV client, the AxiomV mobile app, the Monitoring Desktop, or a floorplan within one minute.

.16 Activity associated with a lockset shall be viewed in real time in the Activity Log.

Part 3 - Execution

3.1 **INSTALLATION**

.1 The contractor shall install all system components in accordance with the manufacturer's instructions, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Power, control, signal and communications, and data transmission lines plus all required grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation. Provide mounting hardware as required.

.2 All products, software, programming tools, etc. shall be registered to The Owner and will be surrendered upon successful completion of the project.

.3 All low voltage wiring outside the control console, cabinets, boxes, and similar enclosures, shall be plenum rated where required by code. Cable shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring.

.4 All inputs shall be protected against surges induced on device wiring. Outputs shall be protected against surges induced on control and device wiring installed outdoors. All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors, except fibre optics, which serve as communications circuits from security console to field equipment, and between field equipment, shall have surge protection circuits installed at each end.

.5 No wiring or cabling shall be exposed; all wiring and cabling must be fully enclosed in threaded metallic conduit, which shall be installed underground, in walls or metal structures unless physically impossible. Any conduit that is exposed shall be fully enclosed within an expanded metal protective cage that is vandal resistant and is equipped with a tamper alarm. All equipment mounting is to be such that the equipment cannot be removed or tampered.

3.2 **CARD READERS**

.1 The access control shall only utilize readers supplied HID Global. The readers will support multi card formats and be available in multiple form factors and transmit power ratings.

.1 Support for iClass, iCLass Seos, MIFARE Classic, MIFARE DESFIRE EV1 @ 13.56 MHz transmit frequency.

.2 Support for HID Prox, Indala Prox, EM4102 Prox at 125 KHz transmit frequency.

.3 Support an operating voltage range of 5-16 VDC.

.4 Support OSDP SC over RS485 for panel communications and reader firmware updates.

.5 Support an operating temperature range -35° C to +65° C.

.6 Support a storage temperature range of -35° C to +65° C.

.7 Support an operating humidity range of 5% to 95% relative humidity.

.8 Carry an IEEE IP55 rating, IP65 with optional gasket, part #IP65GSKT.

.9 Carry the following industry certifications: UL294/cUL and Industry Canada.

.10 Carry a limited lifetime warranty.

END OF SECTION

Part 1 - General

1.1 VMS APPLICATIONS

.1 The enterprise VMS software installed at Owner sites are to be manufactured by March Networks. The system integrator providing the equipment will ensure that all units are in compliance with the general requirements.

1.2 SECTION INCLUDES

.1 Command Enterprise Server Software

.2 8000 Series Hybrid Network Video Recorders

.3 Axis IP Cameras

1.3 RELATED SECTIONS

.1 Section 26 05 00 - Common Work Results for Electrical

.2 Division 27 - Communications

1.4 REFERENCES

.1 Command Enterprise Server Software

- .1 Canadian ICES-003.
- .2 Consultative Committee for International Radio (CCIR).
- .3 Conformity for Europe (CE).
- .4 Electronic Industry Association (EIA).
- .5 Federal Communications Commission (FCC).
- .6 Joint Photographic Experts Group (JPEG).
- .7 National Television Systems Committee (NTSC).
- .8 Phase Alternating Line (PAL).
- .9 Underwriters Laboratories Inc. (UL).

.2 Video Recorders

- .1 Canadian ICES-003.
- .2 Consultative Committee for International Radio (CCIR).
- .3 Conformity for Europe (CE).
- .4 Electronic Industry Association (EIA).
- .5 Federal Communications Commission (FCC).
- .6 Joint Photographic Experts Group (JPEG).
- .7 National Television Systems Committee (NTSC).
- .8 Phase Alternating Line (PAL).
- .9 Underwriters Laboratories Inc. (UL).
- .10 Regulatory:
  - .1 The recorder shall have passed the following safety standards:
    - .1 IEC60950-1 (ed.2)
    - .2 UL 60950-1 (ed.2)
    - .3 CSA C22.2 No.60950-1-07 (ed.2)

.2 The recorder shall conform to the following FCC rules and regulations:
- .1 EMC FCC 47 CFR Part 15 (Subpart 15)
- .2 ICES-003
- .3 EN55022, CISPR 22, AS/NZS CISPR 22
- .4 EN61000-3-2, EN 61000-3-3
- .5 EN50130-4, EN55024

.3 The recorder shall have the following markings indicating compliance with the regulations for sale into the countries that accept the marking:
- .1 CE-mark
- .2 cULus
- .3 C-tick
- .4 WEEE

.3 Axis IP Cameras:

.1 The specified unit shall carry the following EMC approvals:
- .1 EN55022 Class A, EN55024, EN61000-6-1, EN61000-6-2
- .2 FCC Part 15 - Subpart B Class A
- .3 VCCI: 2014, Class A, ITE
- .4 C-tick AS/NZS CISPR22 Class A
- .5 ICES-003 Class A
- .6 KCC KN22 Class A, KN24

.2 The specified unit shall meet the following product safety standards:
- .1 IEC/EN/UL 60950 -1
- .2 IEC/EN/UL 60950-22

.3 The specified unit shall meet relevant parts of the following video standards:
- .1 SMPTE 296M (HDTV 720p)

.4 The specified unit shall meet the following standards
- .1 MPEG-4:
  - .1 ISO/IEC 14496-10 Advanced Video Coding (H.264)
- .2 Networking:
  - .1 IEEE 802.3af/802.3at (Power over Ethernet)
  - .2 IEEE 802.1X (Authentication)
  - .3 IPv4 (RFC 791)
  - .4 IPv6 (RFC 2460)
  - .5 QoS - DiffServ (RFC 2475)

.5 Network video: Relevant ONVIF profile as defined by the ONVIF Organization.

.6 Mechanical Environment:
- .1 IEC/EN 60529 IP66 & IP67
- .2 NEMA 250 Type 4X
- .3 IEC/EN 62262 IK08
- .4 IEC 60068-2-6
- .5 IEC 60068-2-27

1.5 **DEFINITIONS**

.1 Command Enterprise Server Software & Video Recorder

.1 HD (High-definition) - refers to video having resolution substantially higher than traditional television systems. HD has one or two million pixels per frame.

.2 CIF (Common Intermediate Format) - refers to a standard video format, which is categorized based on the resolution.

.2 Axis IP Cameras

.1 General abbreviations and acronyms

.2 AGC: Automatic gain control

.3 API: Application Programming Interface

.4 Aspect ratio: A ratio of width to height in images

.5 Bit Rate: The number of bits/time unit sent over a network

.6 Bonjour: Enables automatic discovery of computers, devices, and services on IP networks.

.7 DHCP: Dynamic Host Configuration Protocol

.8 DNS: Domain Name System

.9 EIS: Electronic Image Stabilization

.10 FPS: Frames per Second

.11 FTP: File Transfer Protocol

.12 H.264 (Video Compression Format)

.13 IEEE 802.1x: Authentication framework for network devices

.14 IP: Internet Protocol

.15 IR light: Infrared light

.16 JPEG: Joint Photographic Experts Group (image format)

.17 LAN: Local Area Network

.18 LED: Light Emitting Diode

.19 Lux: A standard unit of illumination measurement

.20 MBR: Maximum Bit Rate

.21 MPEG: Moving Picture Experts Group

.22 Multicast: Communication between a single sender and multiple receivers on a network

.23 NTP: Network Time Protocol

.24 NTSC: National Television System Committee - a color encoding system based on 60Hz

.25 ONVIF: Global standard for the interface of IP-based physical security products

.26 PAL: Phase Alternating Line - a color encoding system based on 50Hz

.27 PoE: Power over Ethernet (IEEE 802.3af/at) standard for providing power over network cable

.28 Progressive scan: An image scanning technology which scans the entire picture

.29 PTZ: Pan/Tilt/Zoom

.30 QoS: Quality of Service

.31 SIP: Session Initiation Protocol

.32 SMTP: Simple Mail Transfer Protocol

.33 SMPTE: Society of Motion Picture and Television Engineers

.34 SNMP: Simple Network Management Protocol

.35 SSL: Secure Sockets Layer

.36 TCP: Transmission Control Protocol

.37 TLS: Transport Layer Security

.38 Unicast: Communication between a single sender and single receiver on a network

.39 UPnP: Universal Plug and Play

.40 UPS: Uninterruptible Power Supply

.41 VBR: Variable Bit Rate

.42 VMS: Video Management System

.43 WDR: Wide dynamic range

1.6 **SUBMITTALS**

.1 Manufacturer's Product Data: Submit manufacturer's data sheets indicating systems and components proposed for use, including instruction manuals.

.2 Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.

1.7 **QUALITY ASSURANCE**

.1 Manufacturer shall provide customer service, pre-sales applications assistance, after-sales technical assistance, access to online technical support, and online training using Web conferencing.

.2 Manufacturer shall provide 24/7 technical assistance and support by means of a toll-free telephone number at no extra charge.

.3 Installer: Minimum two years' experience installing similar systems, and acceptable to the manufacturer of the video management system.

.4 Power Requirements: Components shall have the following electrical specifications: 100-240 VAC (50 Hz/60 Hz) or as specified for individual products within part 2 of the specification.

.5 Axis IP Cameras:

.1 The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity and evidence that is completed at least three (3) projects of similar design and is currently engaged in the installation and maintenance of systems herein described.

.2 All installation, configuration, setup, program and related work shall be performed by electronic technicians thoroughly trained by the manufacturer in the installation and service of the equipment provided.

.3 The contractor or designated sub-contractor shall submit credentials of completed manufacturer certification, verified by a third party organization, as proof of the knowledge.

.4 The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity that became operational in the past three (3) years.

.5 The specified unit shall be manufactured in accordance with ISO 9001.

.2 System supply, installation and support shall be carried out by one of the following pre-qualified authorized re-sellers.

.1

.2

.3

.4

1.8 **DELIVERY, STORAGE, AND HANDLING**

.1 Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

.2 Handling: Handle materials to avoid damage.

1.9 **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 recommended limits.

1.10 **SEQUENCING**

.1 Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.11 **WARRANTY**

.1 Video Recorder:

.1 The recorder shall have a warranty of at least 3 years.

.2 Should the recorder fail during the warranty period, a replacement recorder shall be available as an advance replacement at no additional cost in order to return the end user to full functionality as quickly as possible.

.2 Axis IP Cameras:

.1 All security system components and labor furnished by the contractor including wiring, software, hardware and custom parts shall be fully warranted for parts, materials, labor and travel expenses for a minimum of three (3) years from date of the final acceptance of the Video Surveillance System.

.2 The manufacturer shall provide warranty and optional extended warranty for the camera for a total period of maximum five years. If enacted as part of the contract, the contractor will repair or replace parts and/or labor per the warranty for the length of this warranty at no cost to the client.

.3 Panasonic Cameras

.1 Provide manufacturer's standard warranty.

Part 2 - Products

2.1 **OWNERS PREFERRED PRODUCTS**

.1

Part 3 - Execution

3.1 **MANAGEMENT SYSTEM COMPONENTS**

.1 Installation:

.1 All components of the video management system shall be thoroughly tested before shipping to the project location.

.2 Video management system shall be installed, programmed and tested in accordance with manufacturer's installation instructions. The integrator shall:

.3 Coordinate interfaces with Owner's representative where appropriate.

.4 Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.

.5 Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent (40 percent) fill in conduits. Gather wires and tie to create an orderly installation.

.6 Coordinate with other trades to provide proper sequencing of installation.

.2 Field Commissioning:

.1 Test video management system as recommended by manufacturer, including the following:

.2 Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.

.3 Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction, as applicable.

.4 Correct deficiencies until satisfactory results are obtained.

.5 Submit written copies of test results.

.3 Training and Certification:

.1 The Enterprise Management software manufacturer shall offer free online training for authorized dealer technicians through user controlled portal access.

.2 Training material shall cover all aspects of installation, configuration and maintenance.

.3 The dealer shall receive a certificate upon the successful completion of the certification exam. Certifications shall be valid for a period of 2 years.

.4 The Enterprise Management software manufacturer shall offer free online training tutorials for system administrators accessible 24/7 via open (non-restricted) website for an unlimited number of system users. The training tutorial shall cover the Enterprise system, User management, Health alert management and Mass Management (upgrades) of all registered devices on the Enterprise Server.

.5 The Enterprise Management software manufacturer shall offer free online training for Guards and Investigators accessible 24/7 via open (non-restricted) website for an unlimited number of system users. The training tutorial shall cover system access, live and archive media requests, alarm inbox management, as well as extracting media from the system

3.2 **INSTALLATION - VIDEO RECORDERS**

.1 Examination

.1 Do not begin installation until substrates have been properly prepared.

.2 Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.

.3 If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

.2 Installation

.1 All components of the recorder shall be thoroughly tested before shipping to the project location.

.2 Recorder shall be installed, programmed and tested in accordance with manufacturer's installation instructions.

.3 Coordinate interfaces with Owner's representative where appropriate.

.4 Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.

.5 Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent (40 percent) fill in conduits. Gather wires and tie to create an orderly installation.

.6 Coordinate with other trades to provide proper sequencing of installation.

.3 Field Commissioning

.1 Test recorder as recommended by manufacturer, including the following:

.2 Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.

.3 Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction, as applicable.

.4 Correct deficiencies until satisfactory results are obtained.

.5 Submit written copies of test results.

.4 Training and Certification

.1 The recorder manufacturer shall offer free online training for authorized dealer technicians through user controlled portal access.

.2 Training material shall cover all aspects of installation, configuration and maintenance.

.3 The dealer shall receive a certificate upon the successful completion of the certification exam. Certifications shall be valid for a period of 2 years.

.4 The recorder manufacturer shall offer free online training tutorials for system administrators accessible 24/7 via open (non-restricted) website for an unlimited number of system users. The training tutorial shall cover the system, User management, Health alert management and Mass Management (upgrades) of all registered devices on the recorder.

.5 The recorder manufacturer shall offer free online training for Guards and Investigators accessible 24/7 via open (non-restricted) website for an unlimited number of system users. The training tutorial shall cover system access, live and archive media requests, alarm inbox management, as well as extracting media from the system.

3.3 **CAMERAS**

.1 Installation:

.1 The Contractors or subcontractors main resources within the project shall carry proper professional certification issued by the manufacturer and verified by a third party organization to confirm sufficient product and technology knowledge.

.2 The Contractor shall carefully follow instructions in documentation provided by the manufacturer to ensure all steps have been taken to provide a reliable, easy-to-operate system.

.3 All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.

.4 All firmware found in products shall be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the Video Management Application (VMA) or Network Video Recorder (NVR).

.5 All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.

.6 A proper installation shall meet NEC (National Electrical Code - US only) per the guidelines of that year's revision. When properly installed equipment meets Low Voltage, Class 2 classification of the NEC.

END OF SECTION

Part 1 - General

1.1 **SUBMITTALS**

.1 Submit shop drawings for products specified in this Section. Include annunciator schedules and sample of graphic annunciator layout and nomenclature.

1.2 **SOFTWARE NOMENCLATURE REPROGRAMMING**

.1 Include additional costs for system manufacturer to make necessary on site final changes to applicable system/equipment software. Make such changes after successful testing and verification of systems, but prior to turn over to Owner. After successful final verification of work, confirm and obtain approval of final nomenclature in writing from Owner and Consultant. Software revisions to incorporate final room names/area names/building names and equipment identification.

Part 2 - Products

2.1 **FIRE ALARM SYSTEM (BASIC ADDRESSABLE)**

.1 Edwards-UTC, "EST3" series, CSA approved and ULC listed and labelled components for a fully electrically supervised, addressable, microprocessor based, single stage, zoned, modular, fire alarm system.

.2 System components to be listed as products of a single manufacturer under appropriate category, by Underwriter's Laboratories of Canada and bear ULC label. system components and work in conjunction with system installation to meet specific application requirements of local governing authorities, codes, standards, regulations and requirements of following:

.1 CAN/ULC-S524;

.2 CAN/ULC-S527;

.3 CAN/ULC-S537;

.4 local governing building code;

.5 local governing electrical code;

.6 local governing building permit applications for approvals;

.7 other requirements of local governing authorities.

.3 Devices to be ULC listed and labelled devices suitable for fire alarm applications. Power supplies and other components to be CSA approved where required by local governing authorities and codes.

.4 System to include following components:

.1 main control panel with liquid crystal display (LCD) and integral light emitting diode (LED) annunciator and system software; capacity for required schedule of zones, system points plus minimum additional spare 25% zones and points;

.2 remote annunciators;

.3 alarm initiating devices;

.4 alarm signalling devices;

.5 batteries and battery chargers, end-of-line devices and required ancillary devices;

.6 wiring in conduit.

.5 Exact type of device to be used in each area of installation to be as recommended by system manufacturer to suit specific applications and to be approved for such use as per ULC standards. Devices in non-climatic controlled areas to be weatherproof, corrosion resistant and ULC listed for use in below freezing temperatures. System manufacturer to be responsible for ensuring compliance with these requirements.

.6 **Control Panel:**

.1 Control panel features:

.1 surface mounted when installed in unfinished areas;

.2 recessed mounted when installed in finished areas;

.3 solid-state microprocessor based technology with LCD and integral LED annunciator with alarm and trouble LED's for each scheduled zone; annunciator provisions to be common with remote annunciator;

.4 dead front, modular cabinet assembly with trim, a hinged door with full glazing, a lock, and keys; door provides access to operator controls, but does not expose live electrical connections; controls, indicators, and operating instructions clearly visible through a viewing window; electrical connections are front access through a removable inner protective cover.

.2 Panel allows for loading or editing of special instructions and operating sequences as required and is capable of on-site programming to accommodate expansion and changes required by local codes. Software operations and instructions are stored in a non-volatile programmable memory in event of loss of primary and secondary power.

.3 On site programming changes to fire alarm system is password protected. During construction stage, obtain approval in writing from Consultant and local governing fire authority, of programming (system sequence of operation) and custom label changes. System software to be custom programme as required.

.4 Include for system programming changes required for duration of project and as required for final acceptance and certification of entire system and project work, by local governing fire and buildings authorities. Include for additional one (1) onsite system reprogramming sessions (duration minimum 4 hours) for any required revisions, after system verification/commissioning. Provide re-burning as required by local governing fire authority.

.5 Ability to selectively program input/output control functions based on ANDing, ORing, NOTing, Timing, and Special Coded Operations is also to be incorporated in resident software programming of system.

.6 System to have ability to manually disable and enable any device/circuit individually, via software, for maintenance or testing purposes.

.7 System can program selected or all smoke sensors for alarm verification operation.

.8 System can program an adjustable time delay circuit for each water flow initiating circuit to prevent false alarms that may be caused by erroneous pressure surges in sprinkler system.

.9 Wiring to any remote annunciator to be supervised for open and ground conditions

.10 Properly ground and bond control panels and remote annunciator cabinets to building ground. Conduit ground will not be acceptable. Provide green coloured grounding loop, a minimum #10 AWG. insulated copper run in conduit. Connect ground loop to main building ground system source. Do not run ground wire in same conduit as fire alarm and communication wiring.

.11 Control panel LCD indicates alarms, supervisory service conditions and troubles. Panel includes but is not limited to following:

- .1 8 lines by 21 character LCD display;
- .2 2500 addressable point capacity;
- .3 15 hardwired circuit capacity;
- .4 local energy, shunt master box, or reverse polarity remote station connection;
- .5 form C trouble contact;
- .6 earth ground supervision circuit;
- .7 front panel ground fault isolation control;
- .8 8 amp intelligent power supply;
- .9 automatic battery charger;
- .10 standby batteries;
- .11 resident non-volatile programmable operating system memory for operating requirements;
- .12 five programmable multi-function keys with status LED's;
- .13 red fire alarm LED and acknowledge button;
- .14 red priority 2 LED;
- .15 yellow supervisory service LED and acknowledge button;
- .16 yellow trouble LED and Acknowledge button;
- .17 green power on LED;
- .18 alarm/signal silence LED and button;
- .19 system reset button;
- .20 operator interface keypad for manual control and system information access;
- .21 addressable interface control modules (as required);
- .22 serial DACT module;
- .23 supervised annunciator circuit.

.12 Control Panel is capable of chronologically logging and storing minimum 300 events in an alarm log and minimum 300 events in a trouble log. Historical logs are stored in CPU's memory and are protected by a lithium battery that is supervised for a low battery condition. Each recorded event includes time and date of that event's occurrence. Alarm log file is separate from trouble log file. User to be able to generate a report of both logs upon request.

.13 Hardwired initiation and control circuits to be individually configurable, on site, in any combination, to provide initiating circuit, signal circuit, or auxiliary control circuit operation. These circuits include a Ground Fault Isolation Relay, allowing them to be isolated via front panel keyboard without having to remove any field wiring.

.14 Initiation circuits/addresses are individually configurable on site to provide either alarm/trouble operation, alarm only, trouble only, current limited alarm, no alarm, normally closed device monitoring, a non-latching monitoring circuit or an alarm verification circuit.

.15 Notification appliance circuits (NAC), (speaker/strobe circuits), are independently supervised and fused such that a fault on one circuit does not affect operation of any of other circuits. NACs are configured as follows:

- .1 Class "B" wiring, current limited;
- .2 rated at two amps of continuous power;

.3 capable of powering polarized 24 VDC audible/visual signalling appliances;

.4 supply two NAC s per floor.

.16 Auxiliary control circuits are as follows:

.1 central Station alarm output;

.2 central station trouble output;

.3 SPDT Form C relays fused at 2 Amp @ 24 VDC.

.17 System Expansion Modules connected by ribbon cables are supervised for module placement. Should a module become disconnected system trouble indicator illuminates and audible trouble signal sounds.

.18 Fire Alarm Control Panel supports 2 RS-232-C I/O ports. CPU data output to I/O ports are in a parallel ASCII format at field adjustable baud rates of 220, 300, 1200, 2400 and 4800.

.19 System is of modular design to allow future expansion with a minimum of hardware additions and system interruptions.

.20 Isolators to be provided between building dividing walls, where required by local governing authorities and codes and as recommended by system vendor.

.21 Control panel to have minimum 25% spare supervisory and annunciating capacity and provide following functions:

.1 fire alarm control;

.2 fire alarm annunciation;

.3 supervisory and trouble annunciation.

.22 Panel to include circuitry and devices to transmit an alarm signal to device(s) provided by others (Owner arranged monitoring company) to send alarm signal to Fire Department or to an outside private protection company, in accordance with CAN/ULC-S561. Exact requirements to be coordinated with monitoring company and and/or security company.

.23 A serial digital alarm-communicating transmitter (SDACT) is a module that mounts internally to and communicates directly with fire alarm control panel. SDACT monitors status of host fire alarm control panel and its connections to central station-monitoring receiver. When status changes require information to be reported, SDACT provides a per point message, (i.e. every addressable device within system on an individual basis), that can assist central station in more accurately implementing required response. Typical information reports include alarms, troubles, and supervisory conditions with specific point identification.

.24 Amplifiers and tone generators supply required signals for tones to audible devices and are sized to accommodate audible device loads (assume 1 watt tapping for determination of amplifier capacity). Amplifiers to be continuously supervised for proper operation. Amplifiers to be sized to include 20% power output spare future capacity.

.7 Walk-test with History Logging: Provide necessary software and programming to provide one-man system testing, as follows:

.1 initiating walk-test mode automatically disconnects auxiliary control circuit relays, and creates a system trouble indication on control panel;

.2 alarm activation of any initiating device causes audible signals to pulse one round of code over alarm signal circuits identifying zone of alarm to testing technician without having to return to control panel. alarm-initiating zone is silently logged as being tested in historical data file. panel automatically resets itself after logging of alarm;

.3 any momentary opening of an initiating or indicating appliance circuit causes audible signals to sound for 4 seconds to indicate trouble condition. trouble condition is silently logged as a trouble condition in historical data file. panel automatically resets itself after logging of trouble condition;

.4 if walk-test feature is on for an inappropriate, (programmable), amount of time, system reverts to normal mode automatically;

.5 actuation of walk-test program not to require any special tools or programming knowledge by Owner or operator.

.8 **Power Supply:**

.1 Control panel accepts 120 volts, 60 Hz as primary source of power for system and additionally provides 24 volts regulated output, current limited distributed system power. Primary power failure of power loss (less than 102 volts) activates common trouble sequence.

.2 Direct current (dc) emergency power supply consists of battery power source to supply sufficient standby capacity to operate entire system upon loss of normal power. Emergency power supply controls, battery charger, and batteries provide an automatic un-interruptible transfer of power to loads during primary power failure or loss. During normal operating conditions a fault in battery charging circuit or a short or open in battery leads, to activate common trouble sequence. Continuous supervision of wiring for initiating and alarm circuits to be maintained during power failure.

.3 Size batteries in accordance with latest requirements of local governing building code. Batteries to be maintenance free, dual-sealed gelled cell type equipped with charging circuits capable of recharging fully depleted batteries to within 70% of their maximum capacity within 12 hours. ampere-hour capacity to be adequate to operate system under supervisory conditions for a minimum of 24 hours with AC power disconnected, and to provide emergency power under full load for local governing building code required length of time but which must be at least 30 minutes at end of this period. Confirm exact requirements with local governing fire authority. Test, verify, and demonstrate these requirements as specified in Part 3 of this Section. system automatically transfers to standby batteries upon power failure. Battery charging and recharging operations are automatic.

.4 Power supply and control equipment include transient voltage surge protective device as recommended and provided by fire alarm system manufacturer.

.9 **Addressable Device Network:**

.1 System provides communication with addressable initiating devices. These devices are annunciated on control panel's main LCD/LED display. Annunciation includes following conditions for each point:

.1 Zone/Device Location;

.2 Type of Device;

.3 Detector Status (Normal/Alarm/Trouble);

.4 Device Missing/Failed.

.2 A minimum of 100 addressable devices may be multi-dropped from a single pair of wires. Systems that require factory reprogramming to add or delete devices are unacceptable.

.3 Communication format is completely digital poll/response protocol. A high degree of communication reliability is obtained by using parity data bit error checking routines for address codes and check sum routines for data transmission portion of protocol.

.4 Each addressable device to be uniquely identified by an address code entered on each device at time of installation. Use of jumpers to set address is not acceptable due to potential of vibration and poor contact.

.5 System supports 100% of addressable devices in alarm or operated at same time, under both primary (AC) and secondary (battery) power conditions. Systems which cannot support 100% of their point capacity in alarm simultaneously are not acceptable.

.6 System to allow a line distance of up to 2,500 feet to furthest addressable device on a Class A communications circuit. Run each addressable loop wired Class A, and run in a Class A conduit system with return run separated by a minimum of 600 mm (24") from primary run. Appropriate quantity of isolator modules to be installed so that a wiring fault (short, open, or ground) within one floor area does not prevent normal operation of other addressable devices on other floor areas.

.10 **Remote Trouble Indicator:** Remote trouble indicator unit includes a yellow LED that illuminates and a low frequency piezo that sounds upon a trouble condition being received at main control panel. unit resets when controlling contact is reset.

.11 **Remote Annunciators:**

.1 Remote active annunciator to be flush wall mounted with baked enamel finish to Architect's direction, and be complete with following features:

.1 alarm LED for each fire zone;

.2 supervisory LED for each sprinkler and standpipe zone;

.3 each zone shown separately and identified by different colour;

.4 alarm and supervisory zones identified with white lamacoid plate with black lettering;

.5 LCD display indicating address of device in alarm and details of system operating conditions;

.6 LED of high intensity types and are supervised;

.7 trouble buzzer;

.8 tamper resistant mounting hardware.

.2 Multi coloured passive graphic display as follows:

.1 electronically stored floor and zone outline, printed on dimensionally stabilized clear film with 3 mm (1/8") thick clear acrylic shield with UV protection;

.2 floor outline and zone area designation depicted by a black border with each zone area represented by a separate colour; egress corridors illustrated with black dotted design with zone colour shown behind pattern; colours and outlines to be confirmed with and approved by Consultant;

.3 exit doors, fire hose cabinets, Siamese connections, elevators, sprinkler pump, gas shut off valves, etc. indicated;

.4 "YOU ARE HERE" notation in red;

.5 a minimum of 6 colours utilized in display;

.6 anodized aluminum frame (minimum 600 mm x 1 m [2' x 3']) to match finish of remote annunciator; finishes to approval of Consultant;

.7 tamper resistant mounting hardware;

.8 approved by local fire authority, where required.

.12 **Addressable Modules:**

.1 Addressable modules to be used for monitoring of water flow, valve tamper, non-addressable detectors, and for control of fans or dampers that require shutdown or manual control in an alarm condition.

.2 Addressable modules to monitor any N/O contact device and be capable of powering 2-wire smoke detectors. Addressable modules will communicate zone's status (normal, alarm, trouble) to transponder. Addressable modules zone address to be set at time of installation via a dip switch package. Where multiple addressable modules are required within a room, (for example a sprinkler room), cabinet mount addressable modules in a locked box, keyed to match fire alarm control panel. Neatly arrange addressable modules for easy contractor connection and label each addressable module with a lamacoid plate providing zone, device address and custom label.

.3 Addressable modules to be able to provide supervised or non-supervised control of any control function. Addressable modules will communicate zone's status (normal, trouble) to transponder. Addressable modules to provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of relay to be equipped with a replaceable 2 AMP fuse. Addressable modules zone address to be set at time of installation.

.13 **Manual Pull Stations:**

.1 Manual pull stations to be addressable, single stage, single action, non-coded, semi-flush mounted type. Pull stations are of die cast metal construction with red enamel finish and "PULL IN CASE OF FIRE" lettering. Stations include front break-glass rod, tamper proof reset function, and one set of N/O contacts. Contacts close when handle is pulled down with single action, breaking glass rod and activating fire alarm condition.

.2 Manual pull stations to be addressable, single stage, dual action, non-coded type. Pull stations are of injection moulded Lexan construction with red enamel finish and "LIFT AND PULL HANDLE IN CASE OF FIRE" lettering. Stations include break-glass rod, key reset function and one set of sealed N/O contacts. Activation requires initially lifting cover and then pulling down handle to cause contacts to close, breaking glass rod and activating a fire alarm condition. Reset station with key switch.

.3 Manual pull stations to be addressable, two stage, single action, non-coded, semi-flush mounted type. Pull stations are of die cast metal construction with red enamel finish and "PULL IN CASE OF FIRE" lettering. Stations include front break-glass rod, tamper proof reset function, one set of N/O contacts and a secondary set of contacts and key switch for general alarm two-stage operation. Contacts close when handle is pulled down with single action, breaking glass rod and activating first stage fire alarm condition. Second stage is activated via key switch.

.4 Addressable pull station electronics including diagnostic LEDs are mounted on station and distinct address is set on station at time of installation.

.5 Include plaster cover for semi-flush mounting and suitable back box. Where surface mounted include for compatible surface mounted style red box. Include additional auxiliary set of contacts where required for interconnection to other building systems.

.6 Equip stations located in areas of high abuse or where designated to be complete with guard, with STI type, ULC listed and labelled, hinged clear Lexan cove. Where specified or where required by code or local fire authority, include integral audible alarm to sound when cover is opened.

.7 For non-climate controlled applications, provide weatherproof STI type, ULC listed and labelled, hinged clear Lexan cover. Where specified or where required by code or local fire authority, include integral audible alarm to sound when cover is opened.

.8 Provide wireguards over stations identified as "WG".

.9 Single stage, standard, key operated manual stations of single stage operation. Station features include:

.1 key operated switch of which key is not easily duplicated;

.2 clear Lexan cover over steel faceplate finished in “Fire Red”;

.3 flush mounts to single-gang electrical box; for surface mounting, include device manufacturer surface type boxes;

.4 English markings silkscreened in large white letters for high visibility;

.5 tamperproof head screws for mounting to backbox.

.14 **Thermal Detectors:**

.1 Surface ceiling mounted addressable automatic thermal detectors with features as follows:

.1 low silhouette design and twist-lock mounting to base;

.2 integral microprocessor with non-volatile memory, automatic device mapping, electronic addressing, self-diagnostics and history log;

.3 LED status indication;

.4 field configurable mounting mechanism to prevent unauthorized removal;

.5 combination 135°F (57°C) fixed temperature and 15°F (9°C) rate-of-rise type;

.6 135°F (57°C) fixed temperature type.

.2 Each detector to be complete with a base plate for mounting to a standard 4" (100 mm) outlet box and cast guards for detectors. Where required, provide an additional alarm relay (Form C, SPDT), normally open contact, for auxiliary functions.

.15 Ceiling Mounted Products of Combustion Detectors:

.1 Surface ceiling mounted photoelectric type, addressable, products of combustion (smoke) detectors with features as follows:

.1 low silhouette design and plug-in mounting to base;

.2 integral microprocessor with non - volatile memory, automatic device mapping, electronic addressing, self-diagnostics and history log;

.3 sensitivity range from 0.6% to 1.9% per foot;

.4 environmental compensation;

.5 identification of dirty or defective detectors;

.6 an integral LED alarm lamp;

.7 locking feature to prevent unauthorized removal of unit head from base.

.2 Each detector to be complete with a base plate equipped with wiring terminals, for mounting to a standard 4" (100 mm) octagon box. Provide cast guards for detectors where identified on drawings. Where required, provide an additional alarm relay (Form C, SPDT), normally open contact, for auxiliary functions.

.3 Detectors tied to hold open devices to be complete with required auxiliary set of contacts. Co-ordinate work with supplier of hold open devices.

.4 Equip detectors with a dust cover, to be removed at time of verification to prevent dust and dirt entering smoke chamber during construction work.

.16 **Detector Bases:** Various types of bases are required to suit each respective application. Confirm with system manufacturer, and provide required type for each application. Types include:

.1 standard type equipped with wiring terminals, for mounting to a standard 100 mm (4") octagon box and complete with tamper-resistant mechanism to prevent unauthorized removal of unit head from base;

.2 relay type with features similar to standard type but includes auxiliary relay;

.3 audible type with features similar to standard type but includes an audible alarm sounder;

.4 isolator type with features similar to standard type but includes line fault isolator.

.17 **Duct Mounting Products of Combustion Detectors:**

.1 Duct type smoke sensor units with features as follows:

.1 addressable photoelectric detector features;

.2 duct air sampling tube of suitable required length;

.3 magnetic activated test switch;

.4 status LEDs;

.5 Form C auxiliary alarm relays;

.6 remote alarm indicator assembly with LED type lamp and single gang stainless steel faceplate;

.7 remote test station for detectors in locations not easily accessible to test.

.2 Duct housing assembly consists of an airtight housing mounted on side of duct, and contains sensor base into which photoelectric sensor head is inserted.

.3 For units located within ductwork as shown on drawings and for units within air intake ductwork, provide weather resistant and corrosion resistant housing complete with integral heater and power supply, and thermostat controller with alarm contacts for monitoring and annunciation of low temperature. Provide system wiring in conduit back to transponder/control panel.

.18 **Flame Detectors**: Ultraviolet type flame detectors as follows:

.1 flame detector to be suitable for intended application of area of coverage;

.2 compact unitized package consisting of detection tube, encapsulated solid state circuitry, dry contact Form C alarm relay;

.3 spectral sensitivity range: 1700 to 2900 angstroms;

.4 temperature range: -25°C to 60°C (-14°F to 140°F);

.5 general purpose painted steel enclosure with protective cage guard;

.6 explosion proof housing for applications in designated hazardous locations;

.7 ancillary relays and accessories as required for connection to system panel.

.19 **Audible/Visual Devices:**

.1 Devices include bells, horns/speakers, strobes and combination units. Devices to mount on wall back boxes. Back boxes to be supplied by system manufacturer to suit specific devices and type of installation. Finish colours to be confirmed with Consultant or Owner prior to ordering.

.2 Bells to be series 439D with features as follows:

.1 24V vibrating bells, 150 mm (6") or 300 mm (12") diameters;

.2 alloy steel gongs, cast aluminum base, red enamel finish;

.3 sound level of minimum 92 dBA at 3m (10');

.4 complete with mounting plate;

.5 where recess mounted include for recessed wall box and prime painted grille.

.3 For finished areas: 757 series re-entrant type horn and horn/strobe units with features as follows:

.1 flush mounting;

.2 temporal or continuous tones to meet local governing authority requirements;

.3 minimum 94 dBA @ 3m (10') at low setting;

.4 faceplate of impact resistant and weather-resistant Noryl construction;

.5 integral synchronized strobe to be complete with Lexan lens, field changeable "FIRE" markings and candela output intensity as approved by local fire authority (range from 15 cd to 110 cd);

.6 back box suitable for flush wall mounting applications.

.4 For finished areas wall mounting: "Genesis G4" series, speakers and speaker/strobe combination units with following features:

.1 compact low profile housing;

.2 consisting of cone speaker and synchronized strobe;

.3 102 mm (4") mylar cone speaker with sealed back construction;

.4 speaker frequency response: 250 to 5,000 Hz;

.5 DC blocking capacitor for audio circuit supervision;

.6 25/70 volt operation with ¼, ½, 1 or 2 watt taps;

.7 sound output to 90 dBA @ 3m (10') tapped @ 2 watts;

.8 integral strobe with Lexan lens; illumination range from 15 cd to 110 cd;

.9 field-configurable temporal strobe output where required by local governing fire authority;

.10 red or white plastic housing with "FIRE" marking on housing;

.11 suitable for mounting on surface or flush back boxes.

.5 For mechanical rooms and non-climate controlled areas: 757 series re-entrant type horn and horn/strobe units with following features:

.1 outdoor rated, weather-resistant;

.2 temporal or continuous tones to meet local governing authority requirements;

.3 minimum 94 dBA @ 3m (10') at low setting;

.4 faceplate of impact resistant and weather-resistant Noryl construction;

.5 integral synchronized strobe to be complete with Lexan lens, field changeable "FIRE" markings and candela output intensity as approved by local fire authority (range from 15 cd to 110 cd);

.6 weather-proof back box suitable for surface or recessed mounting applications to suit required installation requirements.

.6 Stand alone strobes to be similar to features of combination units specified above but only with strobe features.

.7 In finished areas, devices to mount to a 100 mm (4") square, 60 mm (2-1/8") deep, back box. Where devices are to be surface mounted, provide a red finished surface back box with no knockouts.

.8 Devices mounted exterior to be complete with "weatherproof" box.

.20 EVAC Cone Speakers: In finished areas provide a 114 mm (4.5") cone-type speaker with round enamel painted steel baffle suitable for ceiling or wall mount applications. Speaker assembly to consist of following:

.1 fire retardant and moisture proof cone rated 15 watts;

.2 25 volt matching transformer complete with 1/4, 1/2, 1 and 2 watt taps;

.3 220 gram magnet;

.4 80 HZ to 13,000 HZ frequency response;

.5 94 dB at 1.2 m, with a 1 watt input;

.6 moisture repellent treated steel enclosures;

.7 pre-tap speakers at 1/2 watt tap.

.21 Visual Notification Appliances (Strobe Lights): Visual notification appliances to be ULC listed and labelled, equal to Wheelocks Series RSS, synchronized, suitable for intended application with input polarized for standard reverse polarity supervision by fire alarm controls and designed with zero inrush current at 15, 30 and 110 candela intensities. Exact intensities to be to fire authority requirements and as approved by Consultant. Exterior mounted units or units mounted in non-climate controlled areas to be equal to type RSSWP weatherproof type strobes with weatherproof backbox.

.22 Remote Lamp Units: Single gang stainless steel faceplate with LED indicating lamp, suitable for mounting on standard wall box; unit to be remotely connected to any smoke detector located in position where detector activated LED cannot be seen, such as under raised floors, in drop ceilings, above or in ductwork, etc.; smoke detectors to include auxiliary connections to suit connection requirements as per system manufacturer recommendations; provide suitable identification labelling on faceplate.

.23 Fire Signs: "FIRE DO NOT ENTER" custom nomenclature, illuminated, flashing, 24 volt D.C., slim line satin aluminium housing and with black face and red letters; upper and lower rows of long life LED illuminators rated for at least 100,000 hour life, flasher and Lexan guard; lettering of minimum letter size - "FIRE" - 50 mm (2") high, "DO NOT ENTER" - 38 mm (1-1/2") high; lettering not visible until sign is energized.

.24 **Wiring:**

.1 CSA approved and ULC listed wire and cable, approved for fire alarm circuits; with colour coded, insulated solid copper conductors; of type as per local governing electrical code and local governing fire authority requirements; sized and installed in accordance with system manufacturer instructions.

.2 Pentair "Pyrotenax" type "MI" ULC listed and labelled and 2 hour fire rated, mineral insulated, copper sheathed, copper conductors for power wiring to and between each transponder/control panel and applications as required by local governing codes and authorities.

.25 **End-of-Line Resistors:**

.1 End-of-line resistors for standard alarm and signalling circuits, sized to ensure correct supervisory current flows in each circuit.

.2 Mount end-of-line resistors on a stainless steel plate suitable for mounting on a standard single gang wall box.

.26 **Isolators:** Isolators to be provided in accordance with code requirements and installed as per system manufacturer requirements to isolate/monitor zones, loops, group of devices within building and between buildings.

.27 **Warranty:**

.1 Warranty to include following:

.1 a one (1) year repair or replacement warranty on components; full labour costs and no deductible;

.2 warranty to begin upon Substantial Acceptance of Project, or where applicable, phase of Project; provide extended warranty for system if used during construction stages and to cover period of construction before turn over to Owner;

.3 support of an operational remote maintenance capability;

.4 repair response times for problems defined as routine to be addressed and corrected within 24 hours, excepting statutory holidays and weekends;

.5 repair response times for problems defined as major to be addressed and corrected within 4 hours, excepting statutory holidays and weekends;

.6 requirement to have at least one (1) full system of each model provided available in installation area for immediate installation, in case of an entire system failure or catastrophe; such undertaking to be set out in an acceptable plan;

.7 manufacturers of major components to provide written confirmation of full warranty, extended warranty and service back-up in case of failure to perform or insolvency of successful supplier.

.28 **System Inspection, Testing and Verification:** Include for system manufacturer onsite system inspection, testing, verification and certification work, as per requirements specified in Part 3 of this Section. Note that failure to perform such work to complete requirements specified, may at Owner's discretion, affect progress draws and holdbacks.

.29 Acceptable Manufacturers (products and work to be provided directly from manufacturer, unless otherwise noted):

.1 Edwards-UTC (from Chubb Edwards);

.2 Tyco-SimplexGrinnell (from Tyco Integrated Fire & Security);

.3 Siemens Building Technologies (from Siemens);

.4 Notifier (from Vipond);

.5 Mircom Group of Companies (from Mircom Engineered Systems).

Part 3 - Execution

3.1 **INSTALLATION**

.1 Prior to start of Work as part of shop drawing submission process, review with system manufacturer following:

.1 device types to ensure that selected type is suitable for intended application on project;

.2 locations of devices to ensure proper operation and coverage are in compliance with requirements of local fire authorities;

.3 device mounting heights to ensure proper operation and coverage are in compliance with requirements of local fire authorities;

.4 device back box requirements to ensure size and depth suit system manufacturer recommendations for specific devices;

.5 proposed system sequence of operation.

.2 Immediately advise Consultant of any requirements of above that may necessitate revisions to design documents.

.3 Obtain required training from manufacturer representative on any special installation procedures. Install devices and perform work in accordance with the manufacturer instructions and requirements and in accordance to applicable codes of the governing authorities having jurisdiction.

.4 Provide fire alarm system for building in accordance with issued documents and to approval of local governing authorities. Install, test, verify, and certify system as per latest recognized standards indicated herein, local governing building code and as required by local governing fire authority.

.5 Work in conjunction with this installation to meet requirements of latest editions of local governing building code, local governing electrical code, ULC Installation Standard CAN/ULC-S524, and any applicable local codes. If any requirements of these specifications are different, omitted or contrary to ULC-S524 Standard, then ULC Standard governs and overrides these specifications, but in no instance will standards established by drawings and specifications be reduced by any of Codes referred to previously. Control units and annunciators to be in accordance to latest requirements of ULC Standard CAN/ULC-S527 "Control Units For Fire Alarm Systems.

.6 Include for system manufacturer authorized technician to perform system programming work, work within control equipment and final equipment connections. Include for manufacturer authorized representative to perform specified on site software programming sessions for Owner changes, to system after total completion of work and verification of system.

.7 Provide sequence of operation for fire alarm system as approved by local fire authority and Consultant. Contact Owner's fire Consultant with regards to requirements of sequence of operation and any other requirements of system. Submit sequence of operation and proposed graphic displays to local fire authority and Consultant for review during shop drawing submissions. Refer to additional requirements on drawings.

.8 Upon completion of Work, demonstrate system to local Fire Department and obtain their approval for complete system.

.9 Custom program sequence of operation with provisions to allow authorised Owner users to make revisions easily. Following sequence of operation to be considered for Bid Pricing purposes. Exact sequence must be approved by local fire authority and Consultant prior to start of work. Refer to drawing schedule of operations. Submit proposed sequence with shop drawings. Actuation of any alarm initiating device to cause following single stage sequence of operations:

.1 audible devices to sound continuously;

.2 visual devices to illuminate;

.3 zone of alarm condition to be indicated at control panel annunciator and remote annunciator;

.4 zone and address of device in alarm condition to be indicated at control panel annunciator and remote annunciator;

.5 activation of circuitry to transmit an alarm signal to device(s) provided by others (Owner arranged monitoring company) to send alarm signal to Fire Department or to an outside private protection company; this work to comply with CAN/ULC-S561;

.6 designated air handling equipment to start-up or shut-down by means of control wiring from control panel to equipment starters;

.7 release door holders.

.10 Install control panel and remote annunciators in locations. Mount equipment and connect complete in accordance to manufacturer instructions and requirements. Arrange for manufacturer authorized representative to program system with required sequence of operation. Confirm exact sequence of operation with Consultant prior to programming.

.11 Where required by Code and/or local authorities, that power and control wiring connections to control panel and annunciators and from control panel to annunciators are to be fire rated, provide fire rated, ULC listed, conductors (MI) to provide code required fire rating.

.12 Install required devices. Do not install devices in locations that may hamper proper operation of devices including adjacent devices.

.13 Install wall mounting fire alarm panel pull stations in locations and connect complete. Install flush mounted units in a standard 100 mm (4") recessed outlet box with plaster cover. Coordinate type and size of backboxes and outlet boxes with system manufacturer prior to ordering. Install surface mounted units in manufacturers supplied surface boxes.

.14 Provide ceiling mounted products of combustion detectors in locations and connect with wiring. Secure baseplate of each detector to a 100 mm (4") outlet box or surface mounted as required. Where applicable, provide wiring in conduit and connections from smoke detector auxiliary relays to door hold open devices. Co-ordinate work of respective trades.

.15 Interconnect patient room smoke detectors with annunciator at local nurse station and to room nurse call dome lights, as required. Coordinate work and requirements with nurse call system vendor.

.16 Generally, do not install rate-of-rise type of detectors in areas subject to sudden changes in temperatures. Confirm with system manufacturer for recommended type of detector for each application.

.17 Mount each duct mounted products of combustion detector on duct in question and connect with smoke sampling tubes which extend into duct air stream. Install a remote alarm lamp assembly for each duct mounted detector. Wall mount each lamp assembly on a standard 100 mm (4") outlet box as close as possible or practicable to detector. Do not locate duct detectors within 1 m (3') of duct size increaser or decreaser fittings or any duct elbow. Provide wiring in conduit and extend to connect back to system control unit.

.18 Provide alarm bells on standard device boxes in locations. Ensure that sound levels are in accordance to requirements of applicable local Codes and as required by on site audibility coverage tests. Provide required sound meters and personnel to perform tests. Relocate audible devices to suit, or provide additional devices, as required to provide audibility levels to satisfy testing.

.19 Provide alarm horns/strobes on standard device boxes in locations. Ensure that sound levels are in accordance to requirements of applicable local Codes and as required by on site audibility coverage tests. Provide required sound meters and personnel to perform tests. Adjust tapping, or relocate audible devices to suit, or provide additional devices, as required to provide audibility levels to satisfy testing and governing authority requirements.

.20 Provide strobes on standard device boxes in locations. Ensure that light intensity levels are in accordance to requirements of applicable local Codes and as required by on site coverage tests. Provide required meters and personnel to perform tests. Adjust settings, or relocate devices to suit, or provide additional devices, as required to provide levels to satisfy governing authority requirements.

.21 Install devices in stairwells to suit audible/visual coverage requirements and local code requirements. Circuit as required by local code requirements.

.22 Install fire signs in locations and connect such that activation of fire alarm system illuminates sign and when system is reset and alarm has been silenced, sign is de-energized.

.23 In areas of high abuse such as public parking areas, publicly accessible areas, mental health areas and correctional institutions, devices to include vandal resistant, tamperproof and vermin proof features such as guards, fasteners requiring use of special tools and fasteners not exposed.

.24 Devices in non-climate controlled areas to be weatherproof, corrosion resistant, ULC listed for operation in below freezing temperatures, and as recommended by system manufacturer for use for each specific application. Where electronics are not recommended for cold temperature applications, include for manufacturer recommendations and directions in remotely locating addressable modules in closest heated areas and connecting to respective device in non-climate controlled areas.

.25 Provide remote annunciator and adjacent graphic annunciator in location. Unless otherwise noted, install in main entrance vestibule. Co-ordinate backbox installation with general trades work of wall structure. Submit annunciator schedule with shop drawings. Verify zone nomenclature with Consultant prior to installation. Provide proposed drawing and sample of graphic display to Consultant for approval before manufacturing.

.26 In application with hold open devices on doors, ensure compliance with NFPA regarding smoke detectors tied to hold open devices such that a signal received directly from smoke detector must cause release of door. Where electromagnetic locks are used on doors of egress, provide required automatic release of locks upon activation of fire alarm. Provide required connections to fire alarm system and to electromagnetic locks, and provide required contactors and/or relays for connection to control panel.

.27 Provide voltage-sensing relays in each phase, line side, of fire pump controller and standpipe system excess pressure pump starters to sense loss of line voltage. relays are to be energized from 15A-1P breakers and are to be complete with "C" contacts, one (1) per phase, which, if any one (1) phase voltage drops below 90% of nominal, trouble alarm to signal in fire alarm system indicating "Fire Pump Loss of Voltage" or "Standpipe Excess Pressure Pump Loss of Voltage" at annunciators.

.28 Provide an auxiliary N.O. contact in fire pump controller and connect to fire alarm annunciators, powered from fire alarm system to indicate "Fire Pump Running".

.29 Perform required fire alarm system wiring connections to mechanical equipment and other building systems to perform required interrelated functions. Provide required wiring, relays and/or contactors between fire alarm system and various equipment to achieve automatic or manual control of equipment, to perform required integrated to fire alarm system functions. Provide shunt trip breakers as required. Provide ULC listed fire rated conductors where required by local codes and local authorities.

.30 In addition to wiring connections to fire alarm system components, extend control wiring in conduit to (where applicable):

- .1 fire protection system piping supervised valves and flow switches for alarm initiation;
- .2 fire protection system piping supervised valves and flow switches for trouble indication;
- .3 fire protection piping pressure sensors for loss of pressure trouble indication;
- .4 fan equipment starters;
- .5 pumps;

.6 dampers;

.7 fire suppression systems;

.8 door holders/releases and electromagnetic locks master release/reset;

.9 telephone system key switch for connection to offsite central monitoring station;

.10 fire pump transfer switch;

.11 security systems;

.12 BAS system;

.13 dimming systems;

.14 genset control panel;

.15 central inverter;

.16 devices as shown on drawings.

.31 Provisions for elevators to include but not be limited to following:

.1 Minimum 3 dry contacts, one for connections to smoke detectors in lobbies, machine rooms and hoisting, one for connection to smoke sensor activated at designated return landing; and one auxiliary contact for use as confirmed with Division 14;

.2 conduit and wiring from fire alarm control panel to each elevator;

.3 controller: confirm exact requirements with Division 14.

.32 Unauthorized closure of a fire protection system piping supervised valve to cause location of closed signal (audible and visual) to sound and illuminate, and a trouble signal to be transmitted (via a future connection) to Fire Department or to an outside protection agency.

.33 Low pressure in fire protection piping mains (wet and dry), fire protection system pumps (fire pumps-standpipe system excess pressure pump-sprinkler pump, sprinkler system excess pressure pump) loss of power, or operation of fire pumps to also activate audible and visual trouble alarm as specified above for supervised alarms.

.34 Provide end-of-line resistors to electrically supervise wiring. Generally, locate end-of-line resistors at ceiling lines above a pull station location. Provide isolators and install in accordance with ULC standards. Properly label and identify. Do not locate end-of-line resistors and isolators in concealed locations. Generally install in equipment rooms.

.35 Refer to drawing riser diagram. Quantities of components to be as per floor plans and not riser diagram.

.36 Confirm exact location of components and devices prior to roughing-in. Where applicable, confirm component finishes with Consultant prior to ordering.

.37 Install wiring in conduit. Perform wiring connections associated with fire alarm system on terminal strips in junction boxes. When pulling wires into conduit, use lubricant and ensure that wires are kept straight and are not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with approved supports or ties. Clearly label and identify wires at termination points. In addition, number wires with Brady Ltd. or Electrovert Ltd. Z-type markers. Colour conductors for each part of system in accordance with system equipment manufacturer recommendations.

.38 Run alarm signalling circuits (horns/strobes/speakers) and alarm receiving circuits (pull stations, detectors) in separate conduits from each other. Perform wiring connections on terminal strips in junction boxes. Paint conduit couplings for fire alarm system in red enamel.

.39 Where required by local governing codes and/or local governing authorities, provide ULC listed, fire rated conductors (MI) for connections to and interconnections between equipment for life safety applications requiring fire rating.

.40 Provide engraved Lamacoid identification nameplates for each equipment or wiring housing and secure to front of housing. Exact wording designations and sizes to be reviewed and confirmed with Consultant prior to manufacture.

.41 Verify nomenclature of annunciator identification with Consultant and obtain necessary approvals prior to ordering.

.42 Arrange sprinkler system alarm valve alarm zones to be separate from manual station, thermal detector and products-of-combustion detector device zones, which may be connected together into zones.

.43 Provide required double voltage relays for fire alarm wiring work. Provide double voltage relays, with multiple contacts as required, to shut down designated fans. Arrange relays to be energized at all times from fire alarm system to ensure that they are fail-safe.

.44 Ground and bond system as required by local governing electrical code and authority and system manufacturer.

3.2 **SYSTEM TESTING & VERIFICATION**

.1 Submit to Consultant for approval, proposed schedule for testing and verification of system. Obtain such approvals prior to start of testing. Consultant and/or other Owner representatives to have option to witness all or part of testing and verification work. Notify Consultant and Owner minimum seven (7) working days in advance of testing.

.2 When system work is complete and ready for acceptance, arrange for fire alarm system manufacturer authorized technician to inspect, test, verify, and certify equipment, including initiating devices, signalling devices, control devices, and wiring. inspection to comprise of an examination of such equipment in accordance with latest editions of CAN/ULC-S537, for following:

.1 to ensure that entire system functions in accordance with sequence of operations on drawings and as specified;

.2 to ensure that type of equipment installed is that designated by contract documents;

.3 to ensure that wiring connections to equipment components show that installer observed applicable ULC and CSA requirements;

.4 to ensure that equipment was installed in accordance with ULC S524 and manufacturer recommendations, and that signalling devices of whatever manufacture were operated or tested to verify their operation;

.5 to ensure that supervisory wiring of those items of equipment connected to a supervised circuit is operating and that governmental regulations, if any, concerning such supervisory wiring, have been met to satisfaction of inspecting officials;

.6 to ensure that system backup batteries provide sufficient backup power as per local governing building code and local fire authority requirements;

.7 to ensure that system audible devices provide alarm sound levels in each area as per local governing building code and local fire authority requirements; be responsible to site adjust tap settings of audible devices as required to achieve required audibility levels;

.8 to ensure that system visual display devices are located in areas as per local governing building code and local fire authority requirements;

.9 to ensure that each device is commissioned and operable.

.3 Include for full demonstration to Consultant that system batteries and audible devices comply with specification and code requirements.

.4 Arrange for local fire authority inspector to review system and Work. Make any necessary revisions and verify. Pay necessary fees and obtain required approval certificate and turn over to Consultant. Perform necessary re-verifications of Work.

.5 Arrange for manufacturer to supply reasonable amounts of technical assistance with respect to any changes to sub-paragraphs above. During period of inspection and verification, make electricians available to do any required correction work and to assist during inspections.

.6 On completion of verification, inspection and testing of system, obtain from manufacturer and forward to Consultant, a verification certificate together with detailed inspection reports listing each and every system component, its location in building and its acceptability. Manufacturer technician to prepare and sign verification certificates and inspection reports, confirming that system is installed, is working in accordance with requirements specified above and that system has been approved and accepted by local governing fire authority.

.7 Obtain from system manufacturer and forward to Consultant a certificate of liability insurance of minimum amount of Two Million Dollars ($2,000,000.00), that is to be registered for this project to show satisfactory proof of manufacturer's liability coverage for both their product and personnel.

.8 Include for re-verification of any failed device repaired or replaced.

.9 Do not use open flame and/or smoke for testing unless approved by Owner.

.10 System manufacturer to employ technicians certified and approved for fire alarm system testing and verification by Canadian Fire Alarm Association (CFAA) and Ontario Fire Marshall, as applicable.

.11 Submit with test reports, copies of valid certification of testing technician.

.12 Additionally, refer to testing, coordination and verification requirements in Section titled Electrical Work Analysis and Testing and include applicable requirements.

3.3 **TRAINING**

.1 Manufacturer trained technician to perform onsite training of each user (including the provision of user guides) prior to project completion to ensure that users are properly trained in the operation and maintenances of system.

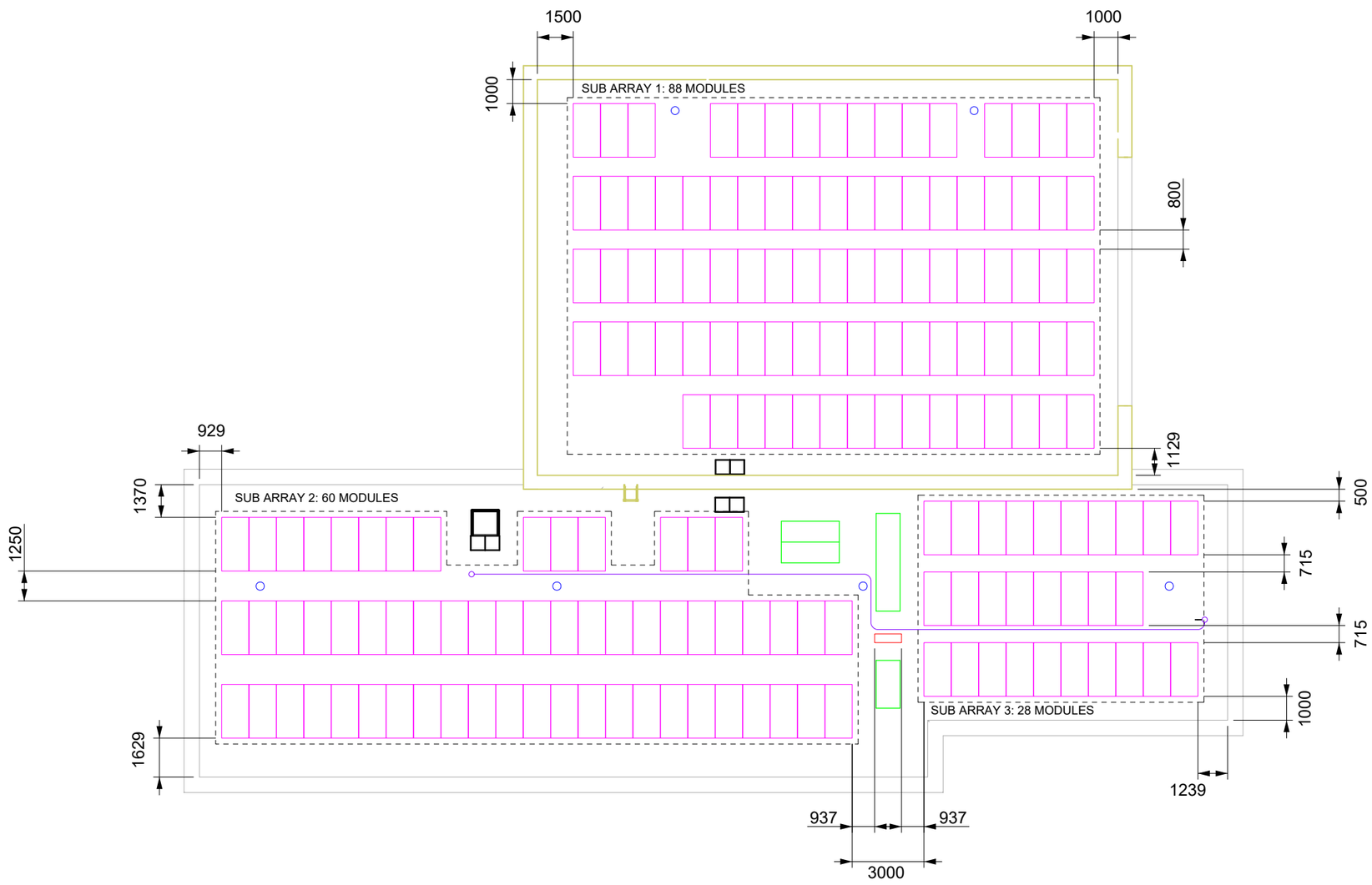
.2 Refer to Instructions to Owner specified in Section titled Electrical Work General Instructions.

END OF SECTION

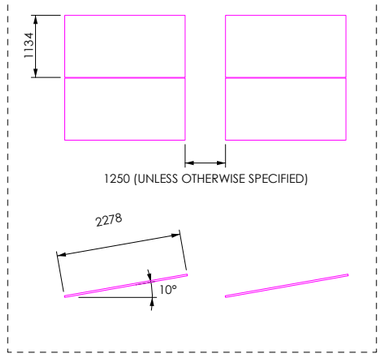
Photovoltaic System Drawings & Specifications by
VCT Group

REVISION HISTORY

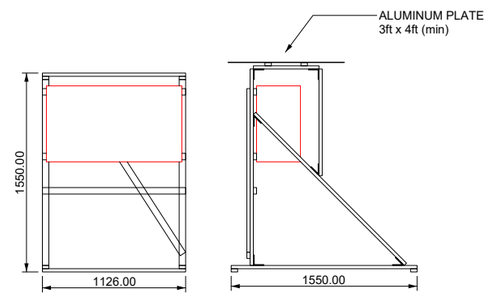
NO.	DATE	REASON FOR REVISION
1	2024-06-24	ISSUED FOR TENDER



TYPICAL PANEL DETAIL (NTS)



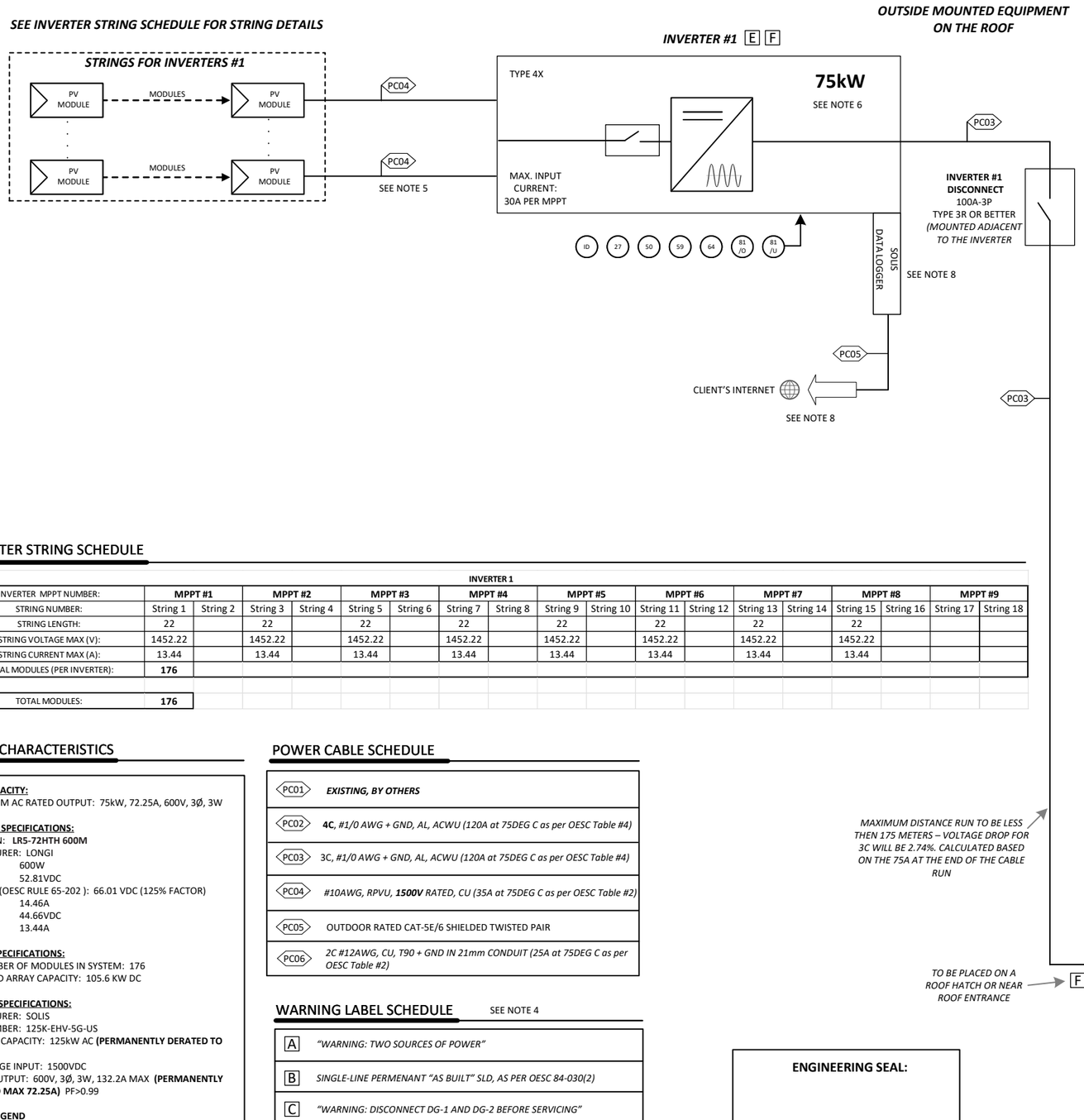
TYPICAL INVERTER STAND

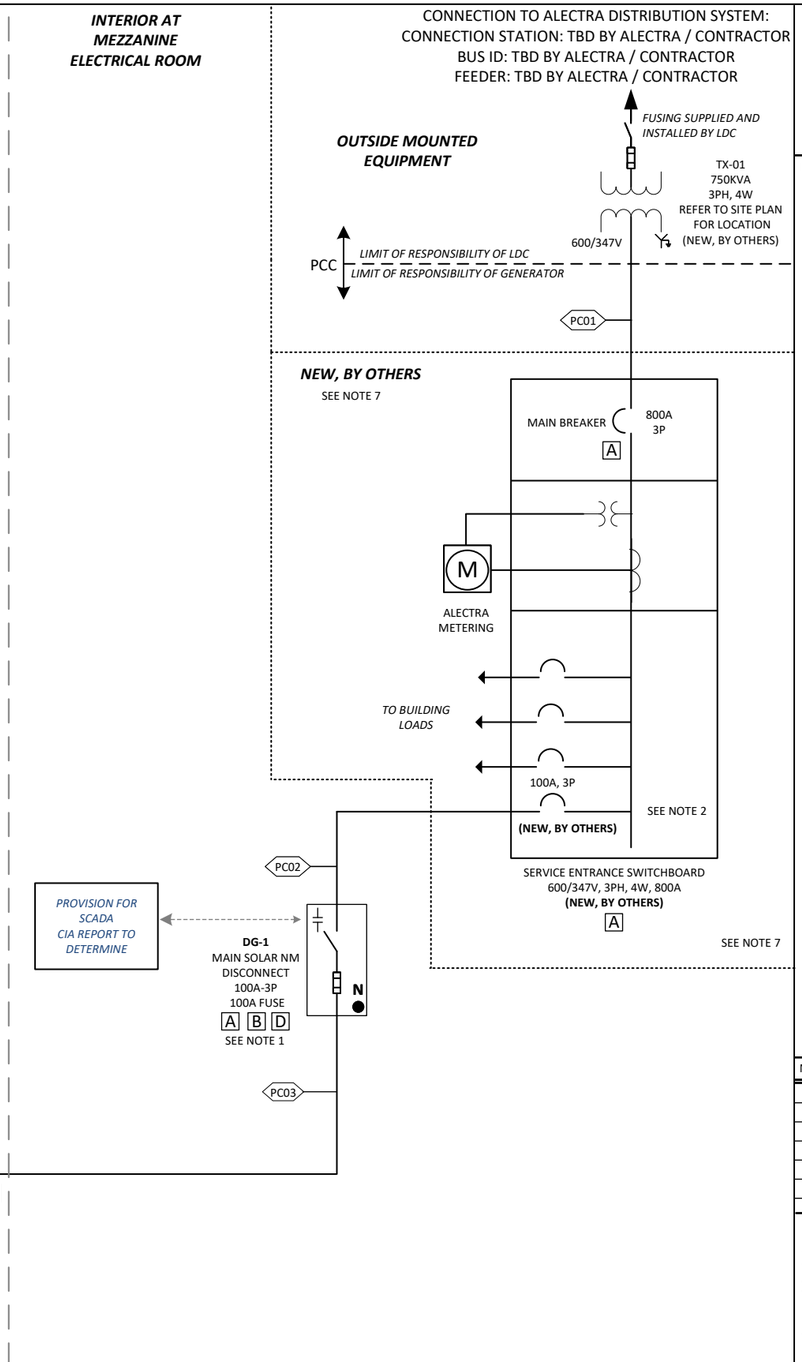


LEGEND:	QTY
PV MODULE: 600 W	176
INVERTER	N/A
HVAC UNIT	N/A
DRAIN	N/A
TRAFFIC ANTENNA WIRING	N/A

SCALE

SHEET NO: 1 : 1		UNLESS OTHERWISE SPECIFIED DIMMENTIONS ARE IN MILLIMETERS X +/- 1mm X.X N/a ANGULAR N/a	PROJECT NAME: 2524 CAWTHRA - FIRE STATION 124 - MISSISSAUGA FIRE & EMERGENCY SEVIVES 75KW NET METER PV SYSTEM		
A3	VCT GROUP		DRAWING TITLE: TENDER RACKING AND PV MODULE LAYOUT		
		DATE: 2024-06-28	MATERIAL: N/A	DRAWN BY: JR	CHECKED BY: _____	REV: 1





INVERTER STRING SCHEDULE

INVERTER 1																			
INVERTER MPPT NUMBER:	MPPT #1		MPPT #2		MPPT #3		MPPT #4		MPPT #5		MPPT #6		MPPT #7		MPPT #8		MPPT #9	
STRING NUMBER:	String 1	String 2	String 3	String 4	String 5	String 6	String 7	String 8	String 9	String 10	String 11	String 12	String 13	String 14	String 15	String 16	String 17	String 18
STRING LENGTH:	22		22		22		22		22		22		22		22			
STRING VOLTAGE MAX (V):	1452.22		1452.22		1452.22		1452.22		1452.22		1452.22		1452.22		1452.22			
STRING CURRENT MAX (A):	13.44		13.44		13.44		13.44		13.44		13.44		13.44		13.44			
TOTAL MODULES (PER INVERTER):	**176**																	

TOTAL MODULES:	**176**

SYSTEM CHARACTERISTICS

SYSTEM CAPACITY:
TOTAL SYSTEM AC RATED OUTPUT: 75kW, 72.25A, 600V, 3Ø, 3W

PV MODULE SPECIFICATIONS:
MODULE P/N: **LR5-72HTH 600M**
MANUFACTURER: LONGI
Pmax: 600W
Voc: 52.81VDC
Voc @ Tmin (OESC RULE 65-202): 66.01 VDC (125% FACTOR)
Isc: 14.46A
Vmpp: 44.66VDC
Impp: 13.44A

PV ARRAY SPECIFICATIONS:
TOTAL NUMBER OF MODULES IN SYSTEM: 176
TOTAL RATED ARRAY CAPACITY: 105.6 KW DC

INVERTER 1 SPECIFICATIONS:
MANUFACTURER: SOLIS
MODEL NUMBER: 125K-EHV-5G-US
NAMEPLATE CAPACITY: 125kW AC **(PERMANENTLY DERATED TO 75 kW)**
MAX. VOLTAGE INPUT: 1500VDC
INVERTER OUTPUT: 600V, 3Ø, 3W, 132.2A MAX **(PERMANENTLY DERATED TO MAX 72.25A)** PF>0.99

INVERTER LEGEND

LINE VOLTAGE AND FREQUENCY SYNCHRONIZATION HANDLED BY INVERTER CSA 22.2 NO 107.1, AND UL1741 IEEE 1547, RATINGS

IEEE DEVICE #:

- (ID) = ISLANDING DEVICE
- (27) = UNDERVOLTAGE
- (50) = OVER-CURRENT
- (59) = OVER-VOLTAGE
- (64) = GROUND FAULT INTERRUPT
- (81 /O) = OVER FREQUENCY TRIP
- (81 /U) = UNDER FREQUENCY TRIP

POWER CABLE SCHEDULE

PC01	***EXISTING, BY OTHERS***
PC02	***4C**, #1/0 AWG + GND, AL, ACWU (120A at 75DEG C as per OESC Table #4)*
PC03	*3C, #1/0 AWG + GND, AL, ACWU (120A at 75DEG C as per OESC Table #4)*
PC04	*#10AWG, RPVU, **1500V** RATED, CU (35A at 75DEG C as per OESC Table #2)*
PC05	OUTDOOR RATED CAT-5E/6 SHIELDED TWISTED PAIR
PC06	*2C #12AWG, CU, T90 + GND IN 21mm CONDUIT (25A at 75DEG C as per OESC Table #2)*

WARNING LABEL SCHEDULE

SEE NOTE 4

A	*"WARNING: TWO SOURCES OF POWER"*
B	*SINGLE-LINE PERMENANT "AS BUILT" SLD, AS PER OESC 84-030(2)*
C	*"WARNING: DISCONNECT DG-1 AND DG-2 BEFORE SERVICING"*
D	*MAX. AC OPERATING VALUES LISTED AS PER OESC 64-072 (1) AND "PV SYSTEM RAPID SHUTDOWN INITIATOR" OR "WARNING - PV POWER SOURCE" AS PER 64-200 (3)*
E	*RATED AND MAX. OPERATING VALUES LISTED AND PV SOURCE CIRCUIT VOLTAGE AS PER 64-200 (1)*
F	*"DANGER 1500V DC" AS PER 64-202 (5c)*

ENGINEERING SEAL:

VCT GROUP
3-5 FORWELL ROAD, KITCHENER, ON N2B 1W3
519-279-4630
WWW.VCTGROUP.COM

NOTES:

1. SWITCH **DG1** IS GENERATOR ISOLATION POINTS PER UTILITY WORKER PROTECTION CODE.
SWITCH DG1 TO BE GANG OPERATED, ALECTRA ACCESSIBLE, ENCLOSED, LOCKABLE, VISIBLE BREAK TYPE. MOUNTED AS PER AGREEMENT WITH ALECTRA.

2. INTERACTIVE POINT OF CONNECTION BUS BAR CALCULATION PER OESC 64-112, 4C
-SOURCE CURRENT RATING: 100A (SOLAR) + 800A (HYDRO) = 900A
-BUS BAR RATING = 800A X 1.2 = 960A
THE POINT OF CONNECTION MUST BE POSITIONED AT THE OPPOSITE (LOAD) END FROM THE INPUT FEEDER LOCATION OR MAIN CIRCUIT LOCATION, WHERE THE PANELBOARD IS RATED LESS THAN THE SUM OF THE AMPERE RATINGS OF ALL OVERCURRENT DEVICES IN SOURCE CIRCUITS SUPPLYING THE PANELBOARD.

4. ALL LABELS MUST BE OF A PERMANENT TYPE, EITHER LASER-ENGRAVED OR ENGRAVED, IN ACCORDANCE WITH RULE 64-200 – MARKING, APPENDIX B TO THIS RULE, AND THE LATEST ESA BULLETIN 64-5-3

5. PV SYSTEM TO BE PROVIDED WITH A RAPID SHUTDOWN WHEN THE PV SOURCE OR OUTPUT CIRCUIT INSULATED CONDUCTORS IS MORE THAN 1 METER FROM THE SOLAR PV ARRAY. MAXIMUM DISTANCE WITH SPLIT SOLAR PV ARRAYS IS 2 METERS AS PER RULES 64-200, 64-218

6. THE SPECIFIED INVERTER MUST BE DE-RATED AT THE FACTORY BY THE MANUFACTURER. AN APPROPRIATE LETTER FROM THE INVERTER MANUFACTURER, SOLIS, MUST BE PROVIDED. THE INVERTER MUST INCLUDE A SECONDARY NAMEPLATE INDICATING THE DE-RATED MAXIMUM CONTINUOUS OUTPUT CURRENT AND DE-RATED MAXIMUM CONTINUOUS OUTPUT POWER RATINGS. IF AN ADDITIONAL NAMEPLATE IS NOT PROVIDED ON THE INVERTER, THE ORIGINAL NAMEPLATE DATA WILL APPLY, WHICH MAY RESULT IN UNDERSIZED CONDUCTORS AND/OR APPARATUS. THIS IS IN ACCORDANCE WITH RULE 64-100(A) AND APPENDIX B TO THIS RULE.

7. EXISTING EQUIPMENT SHOWN ON THIS SLD IS BASED ON EXISTING DRAWING NO. E601 DRAWING NAME: SINGLE LINE DIAGRAM, PROJECT # ALL-23003797-A0, PROJECT NAME: FIRE STATION 124-MISSISSAUGA FIRE & EMERGENCY SERVICES DEVELOPED BY HOSSACK & ASSOCIATES ARCHITECTS (REVISION #1 – ISSUED FOR PERMIT ON 2024-03-21 ANS STAMPED BY J.M POTALIVO P.ENG

8. REFER TO E-701 INTERNET / COMMUNICATIONS / DRAWING FOR DETAILS ON CONNECTION

NO.	BY	DATE	ISSUE OR REVISION
1	RB	JUN 26, 2024	ISSUED FOR TENDER
2			
3			
4			
5			
6			

PROJECT NAME:

2524 CAWTHRA - FIRE STATION 124 - MISSISSAUGA FIRE & EMERGENCY SERVICES 75KW NET METER PV SYSTEM

LDC PROJECT ID#: TBD

ADDRESS:
2524 CAWTHRA RD, MISSISSAUGA, ON L5A 2X3

DRAWING TITLE:
SINGLE LINE DIAGRAM

DRAWING TITLE:	SHEET:	REV:
E-201	1 OF 1	1

INTERNET/COMMUNICATIONS DETAILS

OUTSIDE MOUNTED EQUIPMENT ON THE ROOF

INTERIOR

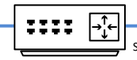
INVERTER #1

SEE NOTE 1, 3

SOLIS DATA LOGGER
MODEL: S2-WL-ST (4 PIN)
TYPE 4X

THE MAXIMUM COMMUNICATION DISTANCE TO BE LESS THEN 75 METERS

NETWORK SWITCH



SEE NOTE 2

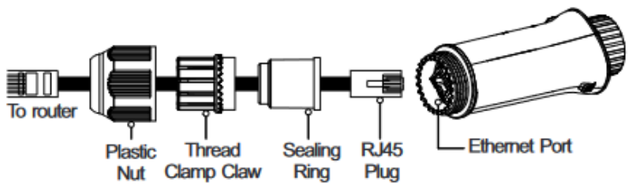
(NEW, BY OTHERS)

SOLIS SMART MONITORING SYSTEM

CLIENT'S INTERNET
(NEW, BY OTHERS)

ENGINEERING SEAL:

NETWORK CABLE INSTALL



SEE NOTE 4

VCT GROUP
3-5 FORWELL ROAD, KITCHENER, ON N2B 1W3
519-279-4630
WWW.VCTGROUP.COM

NOTES:

1. THERE ARE 5 COMMUNICATION TERMINALS ON SOLIS 125K-EHV-5G-US INVERTER. COM1 IS A 4-PIN CONNECTOR RESERVED FOR SOLIS WIFI/CELLULAR DATALOGGER. COM2 AND COM3 ARE RS485 CONNECTION BETWEEN INVERTERS AND BOTH RJ45 AND TERMINAL BLOCK ARE PROVIDED FOR USE. COM 2-5 PORTS – NOT TO BE USED.

2. CLIENT / CONTRACTOR TO PROVIDE AN OPEN PORT WITH INTERNET FOR THE SOLAR PV DATALOGGER MONITORING CONNECTION

3. PLEASE REFER TO THE SOLIS S5 SERIES GRID INVERTER MANUAL VERSION 1.9, RELEASE DATE: 03,2023 (PAGE #31) FOR DETAILS ON THE COMM. & MONITORING SET UP AND DETAILS

4. PLEASE REFER TO THE SOLIS SOLIS WI-FI/LAN STICK DATA LOGGER QUICK INSTALLATION GUIDE VERSION: 1.4 FOR DETAILS ON THE COMM. & MONITORING SET UP

LEGEND:

CAT-5E/6 SHIELDED TWISTED PAIR CABLE OUTDOOR RATER

WIRED / WIRELESS COMMS BY OTHERS

NO.	BY	DATE	ISSUE OR REVISION
1	RB	JUN 28, 2024	ISSUED FOR TENDER
2			
3			

2524 CAWTHRA - FIRE STATION 124 - MISSISSAUGA FIRE & EMERGENCY SERVICES
75KW NET METER PV SYSTEM

ADDRESS:

2524 CAWTHRA RD, MISSISSAUGA, ON L5A 2X3

DRAWING TITLE:
INTERNET/COMMUNICATIONS PLAN

DRAWING TITLE:	SHEET:	REV:
E-701	1 OF 1	1

PART 1 – GENERAL

1.01 SUMMARY

A. Work Included

1. Comply with existing contract, General Requirements and documents referred to therein.
2. Provide design, supply, testing, commissioning, maintenance and operations of PV system.
3. Provide labour, products, equipment, and services to furnish a complete, commissioned, and fully-operational grid-tied Net Metered Solar Photovoltaic (PV) System (including associated instrumentation and monitoring equipment) as specified herein and in the Related Contract Documents in strict compliance with the Referenced Codes & Standards and all requirements of the Authorities Having Jurisdiction.
4. Complete system documentation.

B. Tender Technical and Support Documents:

1. Related Drawings (Issued for Tender – 2024/04/16)
    a. E-101 – Solar Photovoltaic Roof Plan
    b. E-201 – Single Line Diagram
    c. E-801-Racking Layout
    d. E-601 – Site Internet Connection, Cameras

C. General Requirements:

1. All arrays shall be mounted on the roof. All installation shall be non-penetrating type on building roof.
2. The system shall be designed to produce a minimum of 103,000 kWh/year, as verified by system performance modelling.

1.02 REFERENCES

A. Codes and Standards

1. OBC (Ontario Building Code) with all amendments
2. OESC (Ontario Electrical Safety Code), 28th Edition, 2021 (with all amendments and associated bulletins.
3. IEEE1547-2018, Standard for Interconnecting Distributed Resources with Electric Power Systems

4. CAN/CSA C22.2107.1 Power Conversion Equipment
5. UL1741, Standard for Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources
6. CAN/CSA C61215-08 - Crystalline silicon terrestrial photovoltaic (PV) modules
7. UL1703, Standard for Flat-Plate Photovoltaic Modules and Panels
8. UL1699B – DC Arc-Fault Current Protection
9. ULC/ORD C-1703-01 PV Module Safety Standard

1.03 ADMINISTRATIVE REQUIREMENTS

A. Authorities Having Jurisdiction:

1. The Contractor shall comply with all requirements of the Authorities Having Jurisdiction (including, but not necessarily limited to the OBC Principal Authority and the Electrical Safety Authority), as applicable.
2. The installation shall comply with the Ontario Electrical Safety Code (OESC), 28th Edition, consisting of the CSA C22.1-21 Canadian Electrical Code, Part 1 Safety Standard for Electrical Installations (25th Edition) and Ontario Amendments to said standard and all bulletins issued by the Electrical Safety Authority as of the date of permitting.
3. Installation shall comply with the provisions of the ESA SPEC-005 R4 (August 2019), Process Guideline for the Installation of Parallel Generating Systems (Greater Than 10kW).

B. Approvals, Permits and Inspection:
1. The Contractor shall, at the Contractor's expense, apply for and obtain all necessary approvals, permits, and inspections from the Authorities Having Jurisdiction required to complete the work.
2. The Contractor shall, apply for and obtain Connection Impact Assessment through Local Distribution Company with all associated requirements.
3. **The following items are excluded from the Contractor's scope / responsibility**:
   a. CIA Application Fees – by System Owner
   b. Connection Costs / Offer to Connect (per CCA) - by System Owner

C. Contractor Qualifications:
1. The Contractor shall hold all necessary certifications, licenses, and training documentation recommended by product manufacturers and required by the Ontario Building Code, the Ontario Electrical Safety Code, and the Authorities Having Jurisdiction.
2. All contract work is to be conducted in conformance with all applicable legislation (including but not necessarily limited to the Occupational Health and Safety Act and its regulations; the Ontario Fire Code; WHMIS; the Workers' Safety Insurance Board; and other pertinent provincial and federal statutes).

D. Field Supervision:
   1. A designated Contractor Supervisor shall supervise Contractor personnel (including subcontractors, as applicable). This supervisor shall not be changed without prior notice provided to Owner in advance of any transition in staffing.
   2. The Contractor Supervisor shall advise all Contractor personnel (and any other individuals working in close proximity to the PV system) that PV modules generate dangerous electrical potentials and are to always be considered "ON" whenever they are exposed to sunlight. Throughout installation, source string circuits shall be properly secured, covered, and always terminated (or securely capped) when left unattended Contractor personnel to avoid exposure of live wires to individuals on site.
   3. The Contractor Supervisor shall advise all Contractor personnel (and any other individuals working in close proximity to the PV System) that PV modules will be installed **less than 2.5m from the roof edge**. All Ontario required working at heights and fall prevention measures used in these areas shall be the responsibility of the Contractor to ensure safe working conditions in accordance with the Ministry of Labour requirements.

E. Coordination:
   1. The Contractor shall be responsible for obtaining and coordinating all locates for all activities onsite. If field measurements show conflict with any design drawings or specification, the Engineer shall be notified to provide review and formal comment. These field locates provided by the Contractor include, but are not limited to the following:
      a. Roof survey of existing roof condition
      b. Measurements for proposed solar PV equipment locations (walls, ceiling routes, associated clearances, etc.), conduit/conductor paths and associated conduit/cable lengths are the responsibility of the contractor. All measurements shown in design drawings are for reference and/or engineering internal calculation purposes only.
   2. The Contractor Supervisor shall be responsible for coordination of all their subcontractors, in relation to the other sub-trades operating onsite (who may be under the control of the General Contractor).

F. Scheduling:
   1. The solar PV contractor is not permitted to start construction on the solar PV system until:
      i. The LDC required Connection Impact Assessment (CIA) process has been completed.
      ii. Contractor provided Construction Schedule has been reviewed and approved by the Owner.
      iii. Contractor has submitted and received ESA Plan Review
      iv. Contractor has provided stamped single line diagram

v. Roof survey has been provided for review and the racking system layout design is completed by the Contractor, approved survey details (including existing rooftop unit setbacks, roof edge clearances, walkway routes, etc.). Racking design must have been reviewed and approved by the Owner, with resulting final racking design (and associated attachment/ballasting details) having been stamped by a Professional Engineer.
vi. The municipal building department has approved engineered racking design and
issued permit.
vii. The Contractor has obtained a wiring permit for the photovoltaic system from the ESA.

2. Contractor is responsible for obtaining required permit CGR sign-off from the Racking Manufacturer's Mechanical Engineer, including final review for permit closeout purposes.

1.04 SUBMITTALS

A. Existing Condition Roof Survey

1. Prior to the coordination of any detailed PV racking design, the Contractor shall complete and provide a comprehensive, accurate, to scale, existing condition survey of the building roof.
    a. The survey shall be provided in PDF and AutoCAD .DWG formats for review and final PV Array design.
    b. Survey must include all roof top element heights including parapet, elevator shaft, mechanical RTUs, plumbing, venting, services, etc..
    c. Survey shall be accurate to within **50mm (2.0")** to ensure adequate obstruction clearance, resulting shading accuracy, and module layout of the resulting PV array design is maintained, to avoid module relocation(s).

B. Racking System Structural Design

1. Prior to commencing any shop fabrication or site work, the Contractor shall submit electronic copies of the Racking System design for review. These shop drawings shall be stamped and sealed by a Professional Engineer licensed and qualified to provide those services in the Province of Ontario. The submission package shall include:
    a. The array layout
    b. Ballasting details and associated roof loading impacts for building structural review considerations.

c. PV module connection method details and location on the module frame ("green zone"). To be confirmed as acceptable by the PV module manufacturer (via installation manual, or formal letter) prior to finalizing detailed racking engineering.

2. The P.Eng sealed racking system drawings, provided by Contractor, will need to be reviewed and approved by the local building department prior to being accepted for construction purposes.

C. Electrical Specifications

1. Prior to commencing any shop fabrication or site work, the Contractor shall submit electronic copies of the Electrical Specifications design for review. These shop drawings shall be stamped and sealed by a Professional Engineer licensed and qualified to provide those services in the Province of Ontario. The submission package shall include:
    a. Single line diagram
    b. Electrical Equipment layouts

D. Construction Staging Plan / Roof Loading

1. Contractor shall submit their proposed roof staging/loading plan prior to lifting and placing materials on the roof, including size and weight of major items (skids). The staging plan shall be reviewed by the building structural engineer to ensure overall compliance with roof structural capacity allowances.

E. Shop Drawings

1. Provide the following shop drawings for review:
    a. Racking system (to be sealed by a Professional Engineer upon review)
    b. Bonding devices (e.g., WEEBs, lugs, straps etc.)
    c. Photovoltaic modules
    d. PV DC connectors for field installation (Homeruns)
    e. DC conductor, management, and support hardware (within and outside the PV array, including zip-ties, clips, loom etc)
    f. Inverter(s) & optimizers
    g. Inverter circuit AC Panel boards and associated breakers
    h. AC and DC conductors/cables (and all associated Conduit)
    i. Disconnects (switches, non-factory lugs and fuses, contactors)
    j. SCADA control and metering hardware, with control scheme (if applicable)
    k. Single Line Diagram, electrical connection details (to be sealed by a Professional Engineer)

l. Penetration plan
m. Mounting details
n. Labelling and signage details

F. System Performance Calculations- Provide updated energy output calculations based on the product data, system design and site conditions:

G. LDC Requirements

a. Executed Connection Impact Assessment
b. ESA Plan Review

H. Close-Out Submittals
a. Operations and Maintenance Manual (refer to clause 3.11)
b. As-Built Documents

1.05 DELIVERY, STORAGE, AND HANDLING

A. All equipment must be in new condition, and packaging free of dust, moisture, and physical damage.

B. All equipment once onsite must be stored in secure, rigid, dry, weather tight locations free from damage by dust, moisture, or physical abrasion. Equipment stored onsite during construction is the responsibility of the Contractor, interior and exterior storage locations to be approved by site owner.

C. Where practicable, all materials used to protect (e.g., skids, tarps etc.) materials and products shall be reused and recycled at the end of their useful life.

1.06 WARRANTY

A. The Contractor shall provide a minimum full (1) year workmanship warranty covering the entire solar PV system. The warranty shall provide for service at the site including troubleshooting and repair (and/or replacement) of materials & products (including parts and labour). The one-year warranty period shall begin on the date the Owner provides written confirmation of acceptance of the system.

B. The Contractor shall prepare and submit all warranty information and registration documentation required by product manufacturers on behalf of the Owner. Specifically, this is applicable for all major equipment including racking, PV modules, DC devices within array, inverters, transformers (as applicable) and

monitoring system. Copies of all Manufacturer Warranty Documentation shall be included (as specified) in the Operation & Maintenance Manual.

PART 2 – PRODUCTS

2.01 STANDARDS OF MATERIAL AND EQUIPMENT

A. Material and equipment are described in this specification using the following terms.
    a. "Acceptable products" means the bid may be based on any of the listed acceptable products, provided they meet all the specifications. Listing of a manufacturer or product as "acceptable" does not automatically grant acceptance of the product by the Consultant and/or the Owner, nor does it alleviate the Contractor of the responsibility to ensure that any product included in their bid and/or submitted for approval at the shop drawing stage meets or exceeds the requirements of the drawings and specifications.
    b. "Base bid" means the Contractor's bid shall be based on the specified equipment (as listed in this specification document AND Issued for Tender drawing set). Any equipment proposed by the bidding Contractor other than the "base bid" equipment shall be considered "alternative equipment" (see next point).
    c. "Alternative equipment" means any equipment proposed by the bidding Contractor other than the base bid equipment. If "alternative equipment" is being proposed, the Contractor must follow the requirements outlined in the owners RFP information document. In addition, the bidding Contractor shall list all alternative equipment on the Tender Bid Form with the associated cost.
B. No variations in the products, equipment, or procedures described in the Contract Documents shall be permitted without prior written approval . Where variations are proposed by the Contractor, a complete description of the variations (including itemized cost ramifications) shall be submitted in writing for review. Final acceptance of variations shall be at the sole discretion of the Owner based on consultations.

2.02 APPROVAL OF PRODUCTS

1. All products shall be new and free from defects and damage.
2. All products shall be approved in accordance with Ontario Electrical Safety Code (OESC) Rule 2-024 'Approval of Electrical Equipment'.
3. All products shall have labels and documentation demonstrating compliance with the Referenced Codes & Standards and the requirements listed in herein.

2.03 PHOTOVOLTAIC MODULES

A. Solar PV Array Capacity: 105,600 WDC
B. Base Bid: 600W power class (QTY176 + 8 spare, QTY184 Total)
    a. Rated Power (STC): 600 W
    b. Certifications: UL 1703, cUL, CEC
    c. Module Fire Performance: TYPE 1 (UL 1703) or CLASS C (IEC/EN 61730-2)
    d. IEC/EN 61215 - Crystalline Silicon Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval.
    e. Limited Warranty: 10 years on materials and workmanship, 25 years linear performance degradation.
C. Proposed PV Module (model/size) to be provided by the Contractor as part of their Tender bid submission to show compliance with minimum total DC power rating and overall structural load requirements.
D. Base Bid approved Solar PV Manufacturers including:
    a. VSUN
    b. Longi
    c. Trina Solar
    d. Alternative equipment due to availability will be considered and shall be included in alternate bid list; however, ultimate approval is at the discretion of the Owner and the Engineer.
E. The contractor shall supply additional modules in the base bid to be used as spares for future maintenance. A minimum of **5% (QTY 8 PV Modules)** of the final module count, specified in the design, shall be included as spare/additional modules. These additional modules shall be provided to the Owner at the end of the project for safe storage.

2.04 PHOTOVOLTAIC RACKING SYSTEM

A. An As-Built roof survey will be provided by the Contractor prior to final PV array layout design, total module QTY subject to change. The PV array layout provided in Tender design documents is for reference and base bidding purposes only.
B. Bids to be based on a PV module layout design provided in IFT package. Contractor to provide a per module cost (+/- $/unit) to add or remove a module as may be required to account for any layout/quantity variations following the Roof Survey and final approved PV array layout.
C. Pre-engineered rail-based racking system shall be provided by the contractor (including P.Eng seal design and installation).
D. Racking system design shall be compliant with UL-2703 Bonding & Grounding requirements and OESC Rule 64-070 & 64-222.
E. Racking system shall be supplied complete with all necessary structural and mechanical engineering approvals (either provided by the racking company, or a third-party engineer). In any case, all engineering shall be provided by an

engineer licensed (Professional Engineers Ontario) to practice Professional Engineering in the Province of Ontario. All costs associated with these design services is at the expenses of the Contractor.

F. Non-corrosive metal hardware shall be used throughout.
G. Warranty: Racking systems shall have a 10-year warranty on the product.
H. Acceptable products include, but are not limited to the following **Rail-Based** systems:

1. HB Solar – Skyrack SRB
2. TerraGen Solar – TGR
3. Opsun Systems Inc. – Sunrail SRU

I. The proposed racking system must be able to accommodate the minimum DC Target Power, while meeting the above listed structural considerations, and will be reviewed following the Contractor provided Roof Survey to ensure the resulting racking system design is able to accommodate the final module layout configuration
J. Adequate protection shall be provided for all racking system components in contact with the roof system. The Solar PV contractor is responsible for the design (to meet roofing warranty), procurement and installation of any required protection material (e.g., sacrificial layer, matting / insulation). The scope and material required must first be reviewed and approved by the Roofing Manufacturer prior to procurement and installation to ensure the roofing system warranty is not compromised. The approved protection method and material shall be used between any conduit/cable supports or other equipment pertaining to the Solar PV system that is in contact with the roof surface.
K. Alternative equipment will be considered; however, ultimate approval is at the discretion of the Owner.
L. Any/all required additional racking hardware to accommodate DC cable/bonding/grounding management shall be exterior (UV) and direct burial rated. Any attachment hardware required shall be of stainless-steel construction.

2.05 INVERTERS

A. Base Bid: Solis 125K-EHB-5G-US (Derated to 75kW)
   a. AC Output Voltage = 600 VAC, 3Φ 3W
   b. Max Voltage Input = 1500VDC
   c. Certifications: CSA C22.2 No. 107.1-01, IEEE 1547, UL 1741-SA
   d. 10-year warranty (Optional extended warranty will be highly valued in alternate bid)
   e. Alternative equipment may be considered; however, ultimate approval is at the discretion of the Owner

2.06 AC DISCONNECTS, ENCLOSURES,ETC

A. Heavy Duty Safety switches, enclosures, etc, CSA type 3R minimum.

B. Construction:

1. Refer to CSA C22.2 No. 4 – Enclosed Switches for compliance.
2. Refer to CSA C22.2 No. 39 – Fuse holder Assemblies for compliance.
3. To be rated or classified as a Heavy-Duty safety switch.
4. To be constructed of galvanized steel or powder coated steel.
5. Enclosure shall be equipped with visible full load break switching (visible blade).
6. Enclosure shall be ANSI 61 baked gray enamel powder coat finish, trim with concealed front bolts, side hinged (side opening) with dual side latching (minimum), drip hoods for sprinkler proofing and Enclosure CSA type 3R minimum. Bottom opening (top hinged) enclosures are not permitted.
7. Provision for padlocking in off switch position. Lockable in the 'open' position and visually identifiable as disconnected.
8. Mechanically interlocked door to prevent opening when handle in ON position. ON-OFF switch position indication on switch enclosure cover.

2.07 POWER WIRE/CABLE

A. All wire shall be copper unless otherwise noted in the Wiring Schedules provided on drawing PV-201.
B. Install all exterior wiring (outside of the PV Array) in conduit unless otherwise noted. Conduit to be sized per OESC requirements, unless noted on the drawings or in the specifications.
C. PV Array Wire:
    a. Shall be stranded #10 AWG minimum (copper only, not tinned or aluminum) for home runs, and inter-row jumpers, with#12 AWG for factory supplied wires on modules.
    b. All PV Wire shall be contained within the PV array and mechanically protected and fully enclosed between rows, arrays, and to inverters. Use of PVC for mechanical protection within the array, between rows only, is permitted. PVC DC conduits are not permitted outside of the array edge instead ARC must be used as noted previously.
    c. PV array wire from the modules to the DC combiner section of the inverters shall be single-conductor RPVU90 (Minimum Voltage Rating = 600 VDC, Temperature Rating = 90°C, with sunlight resistant black and/or red jacket) CSA listed for use as photovoltaic wire, and utilize certified mated pair quick connectors (from the same manufacturer) and all DC level connections (at the modules and/or inverter).
    d. Conductors other than those described above shall be as indicated below and shown on the drawings:

e. All conductors to have size as indicated with insulation of chemically cross-linked thermosetting polyethylene material rated RW90 or RWU90 to CSA C22.2 No.38 rated as follows:
    i. Insulation rated at 1000V for 600V systems that are ungrounded or have a neutral grounding resistor to limit ground fault current
    ii. Insulation rated at 600V for other 600V and 347/600V distribution systems not covered under item #1 above.
    iii. Insulation rated at 600V for all systems rated at 480V and less.

D. All wire insulation colouration shall be in accordance with the Labeling & Identification section included herein and in accordance with OESC requirements.
E. All wire connections and terminations shall be made solid, safe, and secure in accordance with manufacturer instructions. Only ULC listed and/or CSA certified compression style or screw style connectors, lugs, and terminators may be used.
    a. Certified mated quick connectors (MC4 or similar) should be used for any/all DC string level splice/transition connections. PV module whips are not to be spliced and/or cut.
    b. **AC Conductor splices are not permitted**. Any/all cable and/or conductor damage is to be replaced and not patched/spliced. Proponent will be required to remove and replace the entire length of damaged conductor / cable, with a fully intact equivalent. Applicable to both DC and AC power systems.
F. Standard plastic cable ties and electrical tape shall not be used to support, fasten, or secure conductors, conduit, or cables. Stainless steel PV wire cable clips or specialized UV resistant cable ties w/ metal pawl locking
mechanism suitable for outdoor use will be accepted.
G. Where a conductor or cable is at risk of damage due to abrasion with another component of the system, UV resistant slit tubing (e.g. Heyco-Flex V Nylon Slit Tubing, or Split Loom) shall be applied for protection.

2.08 BONDING & GROUNDING MATERIALS

A. Refer to CSA C22.2 No. 41– Grounding and Bonding of Equipment.
B. Install a complete, permanent, and as required, continuous equipment bonding & grounding circuit for the rooftop PV system. Including all required conductors, connectors and accessories as indicated in the IFT design documents. System grounding details can be found on E-201 of the PV design package, and in some cases exceeds OESC requirements.
C. Protect exposed grounding conductors from mechanical damage.
D. All nuts, bolts, and washers shall be stainless steel rated for exterior environments.
E. Where ground lugs are used, they are to be constructed of copper, be tinned and be rated for exterior or direct burial applications and must be installed per manufacturer direction.
F. Grounding and bonding connectors shall be installed as per manufacturer instructions with respect to both hardware and torque values.
G. When separate hardware not specified by the manufacturer is required to attached lugs to equipment, the connection must be made using through-bolts, of stainless-steel

construction, with a star washer or WEEB between the nut and surface if the equipment. Self-tapping screws will not be accepted.

H. Copper conductors used to ground/bond the racking system shall be fully insulated green jacketed (i.e. RWU90) to provide isolation against galvanic corrosion with dissimilar metals (e.g. steel or aluminum).

I. If required by the manufacturer, apply suitable anti-oxide paste to the exposed ends of conductors before installing them in bonding/grounding lugs.

J. All module frames, panel/array support structures, metal enclosures, raceways, panel boards, disconnects and the inverter equipment shall be bonded to a common grounding conductor terminated in the array and bonded to the service ground as required by the Ontario Electrical Safety Code. All grounding connections and terminations shall be made using permanent non-reversible compression connections.

PART 3 - EXECUTION

3.01 SITE REVIEWS

A. The Contractor is solely responsible for gathering accurate information about the site (including site dimensions, etc.). Site information provided on drawings and in other documents provided by the project team shall be verified by the Contractor.

3.02 SITE MEETINGS

A. The Contractor shall attend all scheduled site meetings as required to review site procedures, schedules, workplace safety, and coordination of the work. This includes all engineer of record inspections and commissioning activities prior to final completion.

3.03 AESTHETICS OF INSTALLATION

A. All products shall be installed to provide a clean and aesthetically pleasing appearance using non-oxidizing/corroding materials. Routing of conduit / cable runs shall be installed per design drawings, or otherwise must be approved by the owner prior to construction and must not interfere with the working space of existing equipment.
B. All at-grade areas disturbed during construction shall be re-established to match original condition (as applicable).

3.04 INSTALLATION OF PRODUCTS

A. Clearances around installed products shall meet all Ontario Electrical Safety Code, OBC & LDC requirements and shall allow for easy access for operation, maintenance, and repair. Products shall be oriented and installed such that access doors are conveniently located and can be fully opened, without restricting interior access.

B. Mounting heights of installed products shall meet all Ontario Electrical Safety Code rules and applicable requirements of the local distribution company and shall allow for easy access for operation, maintenance, and repair.
C. All fasteners (electrical and structural) are to be tightened to the appropriate torque levels as specified by manufacturer literature.
D. All component switches are to be in the OFF or OPEN position and all fuses removed prior to installation. They shall remain in this position, locked-out by contractor, until all OESC/ESA level approvals are obtained, and DG System energization is permitted.
E. Exposed exterior conduit (of any type) at-grade is not permitted. All exterior at-grade mounted equipment conduit/conductor routes shall be direct rear entry only. Any proposed deviation from this requirement must be made in writing and submitted to the Engineer and Owner for review and approval prior to proceeding with associated construction coordination/tasks.

3.05 INSTALLATION OF POWER WIRE/CABLE

A. Unless otherwise noted, all wire/cable shall be installed, routed, and supported per the provided IFT drawing details/notes and all applicable OESC requirements.
B. When using raceways, positive and negative homerun conductors of the same circuit should be placed in the same raceway without separation to help reduce the level of risk associated with lightning induced surges, where practical. This applies within the PV array and in cases where armoured cable with positive and negative insulated conductors is not being used.

3.06 ESTABLISHING BONDING & GROUNDING

A. Comply with all grounding/bonding requirements of the racking manufacturer installation manual to ensure a CSA compliant installation.
B. Ground points to be attached at designated grounding locations as per manufacturer requirements.
C. Comply with the detail diagram as listed on E-201
D. Include dedicated bonding conductor(s), between all major PV system enclosures (DC & AC), regardless of size, length and type of raceway used.

3.07 COMMUNICATIONS AND LOCAL NETWORK

A. Local network connection to be provided by contractor for interconnection of the inverter level monitoring (Inverter server, or equivalent). Location of LAN data drop connection to be verified by contractor.
B. Communication wiring of the rooftop mounted inverter and down to the LAN demarcation to be completed using exterior/outdoor and UV rated, shielded CAT6E minimum ethernet cable. Shielded RJ45 connectors to be used at all terminations.

C. Network cable terminations at the inverter enclosures to be completed using NEMA4 rated (waterproof) communication grommets connectors (if not provided by the inverter manufacturer).
D. CAT6E cables, where exposed to wall penetrations are to be installed in sealed, continuous sections of 3/4" rigid conduit, to avoid cable damage.

3.08 CLEANING

A. The Contractor shall remove all excess compounds, adhesives, sealants, filings, tape residue, dust, and other debris from all PV system products once installation is complete.
B. The Contractor shall remove all packaging, off-cuts, and other miscellaneous debris from the work area and reuse, recycle, or dispose of the waste in accordance with the Owner's requirements (Ontario 3R Regulations).

3.09 IDENTIFICATION & LABELING

A. All source string circuits shall be clearly identified and labeled (within inverter enclosures) for polarity and string by String Number and Inverter Number (INV# - S#). BLACK is the accepted color-coding for negative conductors and RED is the accepted color-coding for positive conductors.
B. Each major PV system component (including inverters, disconnects, transformers (as applicable), meters, and overcurrent devices) shall be clearly identified and labeled as per drawings PV-201 and PV-501 (IFC details), and in accordance with Ontario Electrical Safety Code (OESC) requirements. Components shall be labeled using permanent, self-adhesive, engraved red stock (for Danger), yellow (for Warnings) and black (for other) with white core plastic with a minimum thickness 1/16" or an approved equal.
C. A single-line diagram of the as-built system shall be provided on permanent, self-adhesive, engraved black stock with white core plastic with a minimum thickness 1/16" or an approved equal, and shall be mounted in close proximity to each equipment area identified on
D. All DC conductors shall be sourced with a coloured jacket (RED/BLACK) or labeled with heat shrink for the length of the exposed jacket. Tape is not an acceptable labeling method.

3.08 SYSTEM COMMISSIONING

A. The objective of the commissioning process is to review, verify, and document that the project design meets sound Engineering and installation principles.
B. Installation Verification and Testing
    a. The Contractor shall carry-out a comprehensive visual inspection of the full system.
    b. Testing:
        a. After DC wiring is complete throughout the array, and has been connected to the inverters, the Contractor shall:
            i. Measure and record the open circuit voltage (where possible) and polarity of each string

ii. Measure and record the insulation resistance of all DC conductors (string conductors, before connecting to optimizers).
iii. Measure and record the insulation resistance of all AC conductors using appropriately sized/rated (per conductors being tested) testing equipment.

C. Initial Set-up of Inverters & System Startup
    a. System startup procedures shall be conducted only after all products have been installed and all electrical and mechanical connections have been made secure. The Contractor shall verify that all manufacturer guidelines and recommendations have been followed and the system is correctly installed, properly wired, and safe for startup.
    b. The Contractor shall verify that all necessary approvals, permits, and inspections from the Authorities Having Jurisdiction have been obtained prior to system startup.
    c. The Contractor shall obtain written permission from the Local Distribution Company prior to energizing the system for grid interconnection.
    d. The Contractor shall follow all manufacturer guidelines for system startup procedures and shall provide written notification to the Owner when the system has been energized and system startup has been successfully completed.
    e. Any, and all, major deficiencies identified during initial system startup (safety and/or performance related) shall be corrected by the Contractor before proceeding with formal AC system commissioning (LDC).
D. Communications and Local Network
    a. Following confirmation of inverter startup and operation, the contractor is responsible for confirming that all inverters and associated module level optimizers are fully communicating and uploading operational data to the Solis monitoring server.
    b. The contractor is also responsible for providing Solis “owner level” monitoring access to the Owner. Contractor to request contact emails during commissioning.

3.09 OPERATION & MAINTENANCE MANUAL

A. The Contractor shall submit an electronic copy of a system Operation & Maintenance Manual to the Owner for review
B. The Operation & Maintenance Manual shall include the following information (under separate labeled folders for each item):
    a. Contact information for the Contractor (e.g., address, phone number, email address)
    b. Photovoltaic racking sealed shop drawings.
    c. For every product listed in PART 2 – PRODUCTS:
        a. Product data sheets, manuals & approved shop drawings
        b. Product serial numbers
        c. Manufacturer Warranty Documentation
    d. Contractor As Built Documents

e. LDC Record Drawings Documents
f. Instructions for semi-annual and annual maintenance required for an IEEE 1547 compliant installation.
g. Documentation that all necessary approvals, permits, and inspections from the Authorities Having Jurisdiction have been obtained.
h. Documentation of permission from the Local Distribution Company to energize the system.
i.

3.10 ONSITE TRAINING ONSITE TRAINING SESSION

A. Once the system is complete, commissioned, and fully operational, the Contractor shall provide an On-Site Training Session to demonstrate the typical operation of the DG system for the Owner's personnel at the building. To include, at a minimum:

1. Operation and locations of major equipment in the system
2. Safety related shutdown procedures and identification of main shutdown device.
3. How to identify inverter level errors, either locally at the inverter or though the monitoring portal, and who to contact.

END OF SECTION