

PROJECT MANUAL VOL. 2

Issued for Tender

Mechanical and Electrical

Town of WS Fire Station 5-2 and YR PRS 20

2207

4902 Aurora Road, Whitchurch-Stouffville

DR - indicates entity responsible for preparation of listed documents (see Section 00 01 05)

Document Identification

DR

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1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to:
 - .1 The Contract **CCDC 2-2008**, Stipulated Price Contract as amended,
 - .2 Division 1 requirements and documents referred to therein.
- .2 Section 22 01 01 applies to and governs the work of all Sections of Mechanical Division.
- .3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..
- .4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.
- .5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

1.2 DEFINITIONS

- .1 The following are definitions of words found in this specification and on associated drawings under this Division:
 - .1 "Concealed" - locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
 - .2 "Exposed" - mechanical work normally visible to building occupants.
 - .3 "Furnish" - (and its derivatives) has the same meaning as the term "Supply".
 - .4 "Install" - (and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
 - .5 "Provide" - (and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
 - .6 "Supply" - (and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
 - .7 "Wet" - locations exposed to moisture, requiring special materials and arrangement.

1.3 WORK INCLUDED

- .1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
- .2 Cutting and patching of new or existing work
- .3 Excavating and backfilling
- .4 Identification of equipment, piping, ductwork, and valves and controllers
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches.
- .6 Motors required for equipment supplied under this Division.
- .7 Variable frequency drives for motors and equipment supplied under this Division.
- .8 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.
- .9 Disconnect switches for exhaust fans located on the roof complete with;

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- .1 EEMAC 1 enclosure if housed within a weatherproof cabinet,
 - .2 EEMAC 3 enclosure if exposed to weather
 - .10 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and construction of the new addition. Coordinate this protective work with all trades.
 - .11 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.
 - .12 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.4 RELATED WORK

- .1 Power wiring, conduit and connections for motors under this Division will be by Electrical Division.
- .2 Power wiring, conduit and connections to variable frequency drives for motors under this Division will be by Electrical Division. Wiring and connections from VFD to motors under this Division will be by Electrical Division.
- .3 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.
- .4 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches will be provided under Division 3.

1.5 SUBMITTALS

- .1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.
- .2 Shop Drawings: Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.
 - .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
 - .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
 - .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.
 - .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:
"This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."
- .3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Mechanical Division. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.

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- .4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.
 - .5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:
 - .1 description of the system (description and type),
 - .2 description of the tests conducted and results observed, including re-testing, where necessary,
 - .3 description of any corrective measures undertaken,
 - .4 description of materials used (pipe and fittings),
 - .5 list of witnesses for each test conducted,
 - .6 date system left ready for service,
 - .7 signature of installing Contractor.
 - .6 Directories & Schematics
 - .1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service, and location of each valve under this Division.
 - .2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.
 - .3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.
 - .7 Maintenance Data and Operating Instructions
 - .1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.
 - .2 Ensure the binder spines have typewritten lettering as follows:
OPERATION & MAINTENANCE MANUAL
for
[Insert name of project]
[Insert date of submission]
[Insert Division Title]
 - .3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.
 - .4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.
 - .5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.
 - .6 Ensure operating instructions include the following:
 - .1 General description of each mechanical system.
 - .2 Step by step procedure to follow in putting each piece of equipment into service.
 - .3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
 - .4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.
 - .5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.
 - .7 Ensure maintenance instructions include the following:
 - .1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.

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- .2 Summary list of each item of mechanical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.
 - .3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.
 - .4 Balancing and testing reports.
 - .5 Copy of valve directory.
 - .8 As-Built Records: Prepare and submit complete as-built records in CAD copies prior to Substantial Performance of the Contract. Refer to paragraph 3.2.5 and to Division 1 for requirements.
 - .9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.
 - .10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

1.6 QUALITY ASSURANCE

- .1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.
- .2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:
 - .1 AABC Associated Air Balance Council
 - .2 AMCA Air Moving and Conditioning Association
 - .3 ANSI American National Standards Institute
 - .4 ASA American Standards Association
 - .5 ASHRAE American Society of Heating, Refrigerating, and Air Conditioning Engineers
 - .6 ASME American Society of Mechanical Engineers
 - .7 ASSE American Society of Sanitary Engineers
 - .8 ASPE American Society of Plumbing Engineers
 - .9 ASTM American Society of Testing and Materials
 - .10 AWWA American Water Works Association
 - .11 CAN2 National Standard of Canada (Published by CGSB)
 - .12 CAN3 National Standard of Canada (Published by CSA)
 - .13 CGSB Canadian General Standards Board
 - .14 CSA Canadian Standards Association
 - .15 EEMAC Electrical & Electronic Manufacturer's Association of Canada
 - .16 NBC National Building Code of Canada
 - .17 NEBB National Environmental Balancing Bureau
 - .18 NFPA National Fire Protection Association
 - .19 NEMA National Electrical Manufacturers Association
 - .20 OBC Ontario Building Code
 - .21 OFC Ontario Fire Code
 - .22 OFM Ontario Fire Marshall
 - .23 SMACNA Sheet Metal & Air Conditioning Contractors National Association
 - .24 TIAC Thermal Insulation Association of Canada
 - .25 ULC Underwriter's Laboratories of Canada Ltd
 - .26 UL Underwriter's Laboratories (including cUL)
- .3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.
- .4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.
- .5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.
- .6 All welding and brazing shall be executed by certified welders in accordance with registered procedures.
- .7 All refrigeration work shall be executed only by mechanics with valid ODP cards.

1.7 PRODUCT DELIVERY, HANDLING AND STORAGE

- .1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.
- .2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.8 JOB CONDITIONS

- .1 Visit site and examine existing conditions which may affect work of this Division.
- .2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
- .4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.9 INTERRUPTIONS

- .1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
- .2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
- .4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
- .5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.10 WARRANTY

- .1 Refer to Division 1 and to Section 22 01 01 General Requirements.
- .2 Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.
- .3 Make submissions necessary to register product warranties to the benefit of the Owner.
- .4 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name

1.11 EXTRAS AND CREDITS

- .1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
 - .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
 - .2 Labour hours and unit costs.
 - .3 Total materials and labour costs.
 - .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Ensure materials and equipment provided under this Division are new and free from defects and bear

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- .2 labels of approval as required by codes referred to in this Division and/or by inspection authorities. Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.
 - .3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.
 - .4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 MOTOR STARTERS & CONTROLS

- .1 Mechanical Division shall provide all motor starters and associated controls required and as scheduled on drawings and noted for Mechanical Division equipment. Starters and controls shall be Canadian General Electric or Alternate noted. All starters, contactors, thermal overloads, etc. must be EEMAC rated. All starters shall be of one manufacturer except as specifically approved otherwise for integral pre-wired assemblies.
- .2 Starter and control units shall be equipped with necessary number of auxiliary contacts and relays to provide control sequences described in Mechanical Equipment Starter Schedule on Drawings. Auxiliary contacts shall be interchangeable normally open or normally closed, by conversion in field without additional parts exterior to starter.
- .3 Manual starters may only be provided for single phase equipment operated by control device such as thermostat or limit control when such control device is rated for full electrical load of equipment.
- .4 Manual starters provided for single phase equipment actuated by electric timer or shall have H.O.A. feature. "Hand" position shall permit shunting of time switch. Where such units also have protective device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" positions and shall not be shunted.
- .5 Manual starters may only be provided for three phase equipment which is not actuated by pilot control device (pressure switch, float switch, safety limit devices, remote manual control device) unless otherwise noted in Starter Schedule.
- .6 Magnetic starters for manually operated equipment shall have "On/Off" selector switch or "Start-Stop" pushbutton in cover as scheduled.
- .7 Magnetic starters which are started automatically by electric time switch shall include "Hand-Off-Automatic" (H.O.A.) selector switch. "Hand" position shall permit shunting of time switch or E.M.S. Where such units also have protective pilot device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" position and shall not be shunted.
- .8 Magnetic starters which are started automatically by remote pilot device (or interlocked units) such as level controller, pressure switch, thermostat or flow switch shall include "Hand-off-Auto" (H.O.A.) selector switch, and, where scheduled, a "Test" pushbutton. "Hand" position shall permit shunting of remote pilot device and thereby permit operation of starter but only while depressing "Test" button.
- .9 Equip starter apparatus for prime plumbing, heating, air conditioning and ventilating equipment so that these units will automatically restart on resumption of power after power outage. Starters for these units shall have "On/Off" selector switch in cover if not fitted with H.O.A. selector feature or manual starter or otherwise noted.
- .10 Safety control device such as flow switches, pressure switches, high and low limited ("Fire" and "Freeze") shall not be shunted by "Hand" position of switch.
- .11 Manual motor starter shall be toggle operated with following general construction features:
 - Quick-Make, Quick-Break mechanism with double-break contacts.
 - Overload protection heaters, one per phase and speed.
 - Enclosure to suit application.
 - Pilot light, neon lamp.
 - Cover engraved with "On-Trip-Off".
- .12 Magnetic motor starters shall comprise electrically-operated motor starters combined with disconnect switch with following general construction features:

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- Quick-Make, Quick-Break mechanism with double-break contacts.
 - Fuse holders to accept specified fuses, one per phase.
 - Adjustable overload relays, one per phase.
 - CEMA listed enclosure to suit application. Disconnect with mechanical cover interlocks, line side barriers and switch operated electrical interlocks to disconnect external control voltage unless starter includes suitable approved enclosed contacts and connections.
 - "Reset" button.
 - Pilot Lights of transformer type incandescent with amber safety lens cap.
 - Control transformer with 120 volt fused secondary and sized to suit current rating of associated control devices.
 - Scheduled cover mounted control devices with standard duty double break contact blocks.
 - Minimum of two auxiliary contacts (unused "Seal-in" contact may be included).
- .13 Contactors for non-motor applications shall be built similar to combination magnetic starters, except less overload relays, and with Gould Shawmut AJT time delay HRC1-J fuses, rated for load, and with enclosed continuous current rating of at least 125% of connected full load.
- .14 "Double Voltage Relays" shall be CGE Model CR120 LXMC with general purpose enclosure, number of contacts required and "Mylar" shroud of enclosure of contacts, or approved equivalent.
- .15 Pilot devices such as "Start-Stop" pushbuttons, "Hand-Off-Auto" selector switches and indicating lights shall be of heavy-duty construction. Indicating lamps shall be transformer type incandescent with amber safety lens caps.
- .16 Each control unit shall be provided with engraved nameplates for designation of device controlled and duty. See Subsection "Equipment Markers & Nameplates" for details.
- .17 Control wiring shall be 120 volt A.C. maximum. Provide control circuit transformers where these are not included in motor starters. Secondaries of control transformers shall be fused with one side grounded and controls, safety devices and interlocks shall be connected in ungrounded conductor, excepting only integral starter overload devices.
- .18 Single phase motors interlocked to start or operate with other equipment shall be provided with magnetic starters or suitable relays with necessary auxiliary contacts and double voltage relays or be otherwise electrically separated.
- .19 Overload relay heaters for starters shall be selected and field adjusted to trip at maximum value of 115% of actual nameplate full load amperes. Selection of heater elements shall be based on starter manufacturer's recommendations. Obtain data from Mechanical Division. Submit Motor Starter Schedule which shall list following for each motor:
- Proposed equipment nameplate data
 - Actual full load amperes of motor
 - Speed of motor
 - Temperature Class in degrees Celsius rise and insulation class.
 - Circuit breaker or fuse type and proposed rating
 - Type of motor, duty and service factor.
- .20 Overload relay heaters shall trip in 20 seconds or less from cold or motor-locked rotar condition.
- .21 Where equipment is noted to be electrically interlocked, provide necessary interlocks, double voltage relays (Mylar shroud accepted) to provide specified operation.
- .22 Provide all fuses required to protect equipment. Fuses shall be proper size blade type time delay HRC1-J current limiting. Supply three spare fuses of each size and type and obtain duplicate receipt for same. Fuse clips shall reject standard NEC fuses. Fuses shall be rated in accordance with manufacturer's published data. Fuses to be of one manufacturer throughout.
- .23 Acceptable Alternate Manufacturers
1. Furnas Electric
 2. Westinghouse
 3. Allen Bradley
 4. Square 'D'
 5. Cutler Hammer
 6. Klockner-Moeller.
 7. Commander
 8. Telemecanique

2.3 EQUIVALENTS AND ALTERNATIVES

- .1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.
- .2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.
- .3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to indicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

- .1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.
- .2 Apply, in writing, to Consultant for substitution of any products, indicating the following:
 - .1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
 - .2 Reason for substitution.
 - .3 Any revisions to the contract price made necessary by substitution.
 - .4 Any revisions to the contract time made necessary by substitution.
 - .5 Any revisions to layout, arrangement or services made necessary by substitution.
- .3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

- .1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.
- .2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

3 Execution

3.1 RELATIONSHIP WITH OTHER TRADES

3.2 INSTALLATION REQUIREMENTS

- .1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
- .2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.

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- .3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
 - .4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
 - .5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
 - .6 Provide suitable shielding and physical protection for devices.
 - .7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
 - .8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
 - .9 Do not use powder activated tools except as permitted by the Prime Consultant and the Owner's workplace health and safety policies.
 - .10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.3 CONTRACT DRAWINGS

- .1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
- .2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.
- .3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.
- .4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.
- .5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.
- .6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.
- .7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

3.4 CONSTRUCTION DRAWINGS

- .1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.
- .2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.
- .3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.
- .4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.
- .5 Submit construction drawings prior to commencement of work.

3.5 RECORD DRAWINGS

- .1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".
- .2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting

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- procedures consistent with quality and standards of Consultants documents.
 - .3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.
 - .4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.
 - .5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.
 - .6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

3.6 USE OF EQUIPMENT

- .1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.
- .2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the edges are sealed so that the filters are not bypassed. Change the filters frequently, to the satisfaction of the Consultant, until the building is turned over the Owner.

3.7 SPECIAL TOOLS AND SPARE PARTS

- .1 Within 30 days of award of contract, prepare a complete itemized list of special tools and spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.
- .2 On completion of the project furnish spare parts to the Owner as follows:
 - .1 One set of mechanical seals for each pump.
 - .2 One casing joint gasket for each pump.
 - .3 One head gasket for each heat exchanger.
 - .4 One glass for each gauge glass installed.
 - .5 One set of v-belts for each piece of machinery.
 - .6 One set of new filters for each filter bank installed.
- .3 Identify spare parts containers as to contents and replacement parts number.
- .4 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

3.8 INSTRUCTION

- .1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instruction for each system separately.
- .2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
- .3 Ensure each instruction period includes, but is not limited to the following;
 - .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
 - .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
 - .3 demonstration of the proper operating procedures for each item of equipment,
 - .4 explanation of the purpose and function of all safety devices provided,
 - .5 demonstration of all measures required for safe and proper access for operation and maintenance.
- .4 Provide a period of follow-up instruction (on two occasions) approximately one month after

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- completing Owner's instruction to clarify and reinforce earlier instructions.
 - .5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

3.9 START UP AND COMMISSIONING

- .1 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
- .2 The Startup and Commissioning Team shall be comprised of;
 - .1 The individual, company or agency undertaking the work of each Section,
 - .2 Representatives of the Contractor and his sub-contractors as required,
 - .3 Representatives of equipment manufacturers,
 - .4 Representatives of the Consultants,
 - .5 Representatives of the Owner.
- .4 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the startup and commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.
- .5 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.
- .6 Each Section shall prepare Check Sheets in accordance with the standards listed above and shall issue them to the commissioning team for use during the commissioning process.
- .7 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;
 - .1 name and logo of Facility,
 - .2 name of the project,
 - .3 the Owner's project number,
 - .4 identification of the system commissioned,
 - .5 the date that the system was commissioned.
- .8 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

END OF SECTION

PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 1.

1.2 APPLICABLE STANDARDS

- .1 Applicable Standards are listed below:
 - .1 ASHRAE Standard 202-2024 - The Commissioning Process Requirements for New Buildings and New Systems
 - .2 ASHRAE Standard 230-2022 - Commissioning Process for Existing Buildings and Systems
 - .3 ASHRAE Guideline 0-2019 - the Commissioning Process
 - .4 ASHRAE Guideline 0.2-2015 - Commissioning Process for Existing Systems and Assemblies
 - .5 ASHRAE Guideline 1.1-2025 - Application of the Commissioning Process to New HVAC&R Systems
 - .6 ATSM E2813 – Standard Practice for Building Enclosure Commissioning
 - .7 ATSM E2947 – Standard Guide for Building Enclosure Commissioning
 - .8 CaGBC LEED v4.1 Building Design and Construction Reference Guide
 - .1 LEED EAp1: Fundamental Commissioning and Verification
 - .2 LEED EAac1: Option 1. Path 1: Enhanced Commissioning
 - .9 CSA Z320-11 Building Commissioning Standard & Check Sheets
 - .10 CSA C282-15 – Emergency Power Supply for Buildings
 - .11 NIBS Guideline 3-2012 – Building Enclosure Commissioning Process

1.3 GENERAL

- .1 The purpose of this section is to specify Division 22 responsibilities in the commissioning process.
- .2 Commissioning requires the participation of Division 22 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 22 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.4 SYSTEMS TO BE COMMISSIONED

- .1 Systems to be commissioned as part of this contract include, but may not be limited to the following:
 - .1 Plumbing, including domestic hot water systems, pumps and controls
 - .2 Applicable meters

1.5 COMMISSIONING TEAM

- .1 The Commissioning Team shall consist of representatives of the following as appropriate:

- .1 Owner and the Owner's FM Staff
- .2 Consultant
- .3 Commissioning Authority (CxA)
- .4 General Contractor (GC)
- .5 Subcontractors (Mechanical, Electrical, Controls, TAB)
- .6 Specialized third-party for verification

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 COMMISSIONING AUTHORITY RESPONSIBILITIES

- .1 The Commissioning Authority shall:
 - .1 Plan, organize and implement the commissioning process as specified herein;
 - .2 Prepare the commissioning plan, ensure its distribution for review and comment;
 - .3 Revise the commissioning plan as required during construction;
 - .4 Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
 - .5 In conjunction with the GC, coordinate commissioning activities;
 - .6 Monitor system verification checks, and ensure the results are documented as the checks are done;
 - .7 Observe select start-ups and initial system operations tests and checks;
 - .8 Develop Functional Test scripts
 - .9 Direct the GC to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
 - .10 Witness functional performance tests and document the results;
 - .11 Prepare and submit a commissioning report which documents all checks and tests done throughout the commissioning process, and the results obtained from each;
 - .12 Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated facility operating staff.

3.2 CONSULTANT RESPONSIBILITIES

- .1 The Consultant commissioning responsibilities are outlined below:
 - .1 Review the commissioning plan, proposed test procedures, and participate (as appropriate) in on-site commissioning meetings.
 - .2 At their discretion during the acceptance phase of the commissioning process, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance

3.3 OWNER/ PROJECT MANAGER RESPONSIBILITIES

- .1 The Owner shall have the following commissioning responsibilities
 - .1 Ensure the availability of facility operations staff for all scheduled instructions and demonstration sessions (training).
 - .2 At their discretion, witness commissioning performance tests.

3.4 SUBCONTRACTOR RESPONSIBILITIES

- .1 The Contractor shall ensure that the Subcontractor complies with all requirements included in this Section and fulfills the following responsibilities during construction and acceptance phases in addition to those listed above are (all references apply to commissioned equipment only)
 - .1 Documentation of all procedures performed shall be provided and forwarded to the Consultant. Written documentation must contain recorded test values of all tests performed per the individual product specification.
 - .2 The start-up service company shall be present during energization of the plumbing equipment. Jobsite and equipment access must be provided by the Subcontractor.
 - .3 The Contractor shall supply a power source, specified by the start-up service company, for on-site test equipment.
 - .4 The subcontractor is to attend all factory witness testing required within the respective specification sections. All costs associated with the plumbing system commissioning specified in this Section shall be included in the bid price.
 - .5 Perform tests using qualified personnel. Provide necessary instruments and equipment.
 - .6 Include the cost of commissioning in the contract price, if not yet included.
 - .7 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
 - .8 Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
 - .9 Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of pre-functional and functional testing procedures.
 - .1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation 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 Commissioning Authority.
 - .2 The Commissioning Authority may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
 - .10 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CxA for review.

- .11 Contractors shall assist (along with the Consultant) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- .12 Provide assistance to the CxA in preparation of the specific functional performance test procedures specified in Division 22. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- .13 Develop a full start-up and checkout plan using manufacturer's start-up procedures and the pre-functional test sheets from the CxA. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CxA for review.
- .14 During the startup and checkout process, execute and document the mechanical-related portions of the pre-functional test sheets provided by the CxA for all commissioned equipment.
- .15 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
- .16 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. 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.
- .17 Perform functional performance testing under the direction of the CxA for specified equipment to be commissioned. Assist the CxA in interpreting the monitoring data, as necessary.
- .18 Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC and Consultant and retest the equipment.
- .19 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- .20 During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for subcontractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for subcontractor-generated coordination drawings
- .21 Provide training of the Owner's operating personnel as specified.
- .22 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- .23 Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
- .24 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- .2 Assist and cooperate with the Mechanical and TAB contractor and CxA by:
 - .1 Putting all equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
 - .2 Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
- .3 Install a P/T plug at each water sensor which is an input point to the control system.

- .4 List and clearly identify on the as-built drawings the locations of applicable sensors and meters.
- .5 Prepare a preliminary schedule, in conjunction with Division 25 Contractors for Division 22 pipe system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.
- .6 Notify the Consultant, Owner/PM, GC or CxA depending on protocol, when pipe system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the Consultant, GC, or CxA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CxA has the scheduling information needed to efficiently execute the commissioning process.

3.5 SUBMITTALS

Division 22 Contractors shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 01 91 00 for additional Division 22 requirements.

3.6 START-UP OF EQUIPMENT

- .1 The Subcontractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 00, Part 3.10. Division 22 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA or Owner.
- .2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the Consultant, CxA and GC. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre functional checklists as soon as possible.
- .3 Prior to the start-up of equipment, the Division 22 Subcontractor shall arrange to have the Manufacturer of all major equipment inspect the installation to ensure their equipment has been installed in accordance with their recommendations. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory, and the system is ready for safe start-up.
- .4 The Supplier shall submit a written report of their findings.
- .5 Upon confirmation that the equipment has been installed in accordance with the Manufacturers Recommendations the equipment may be started.
- .6 All equipment shall be started by the Manufacturer's representative.

3.7 PRE-FUNCTIONAL TEST SHEETS

- .1 Pre-functional test sheets contain items for Division 22 Contractors to perform. On each checklist, a column is provided that is to be completed by the contractor assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.

- .2 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout.

3.8 FUNCTIONAL TESTING, DOCUMENTATION, NON-CONFORMANCE AND ACCEPTANCE

- .1 Refer to Specification 01 91 00 for more information in addition to this 22 08 00.

3.9 OPERATION AND MAINTENANCE MANUALS

- .1 Division Contractors shall compile and prepare documentation for all equipment and systems covered in Section 22 and deliver to the GC for inclusion in the O&M manuals.
- .2 ASHRAE Guideline 4-2008 is the recommended format.
- .3 The CxA shall receive a copy of the O&M manuals for review.

3.10 TRAINING OF OWNER PERSONNEL

- .1 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 00 for additional details.
- .2 The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 00 for additional details.
- .3 The Subcontractor shall have the following training responsibilities:
 - .1 Provide the CxA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.14.
 - .2 Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of commissioned plumbing equipment
 - .3 Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, 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 person 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 is 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 operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 - .7 Training shall include:
 - .1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - .2 A 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, shut-down, 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 Explanatory 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.
- .4 The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1, latest edition
 - .5 Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
 - .6 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
 - .7 The mechanical subcontractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
 - .8 Training shall occur after functional testing is complete, unless approved otherwise by the Consultant and/or Owner/Project Manager.

3.11 DEFERRED TESTING

- .1 Refer to Section 01 91 00, Part 3.15 for requirements of deferred testing.

3.12 WRITTEN WORK PRODUCTS

- .1 Written work products of Section 22 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets. Refer to Section 01 91 00 Part 3.16.

END OF SECTION

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

- .1 Pipe, pipe fittings, valves, and connections for piping systems.
- .1 Storm Sewer.
 - .2 Sanitary Sewer
 - .3 Sanitary Vent
 - .4 Domestic (Potable) Water.
- .2 Disinfection of potable water distribution system.
- .3 Testing and reporting results.

1.3 REFERENCES

- .1 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .3 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- .4 ASME B16.26 - Copper Alloy Bronze Fittings for Flared Copper Tubes.
- .5 ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- .6 ASME B16.32 - Cast Copper Alloy Solder Joint Fittings for Solvent Drainage Systems.
- .7 ASTM A74 - Cast Iron Soil Pipe and Fittings.
- .8 ASTM B32 - Solder Metal.
- .9 ASTM B42 - Seamless Copper Pipe, Standard Sizes.
- .10 ASTM B68 - Seamless Copper Tube, Bright Annealed.
- .11 ASTM B75 - Seamless Copper Tube.
- .12 ASTM B88 - Seamless Copper Water Tube.
- .13 ASTM B251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
- .14 ASTM B302 - Threadless Copper Pipe, Standard Sizes.
- .15 ASTM B306 - Copper Drainage Tube (DWV).

1.4 SUBMITTALS FOR REVIEW

- .1 Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Project Record Documents: Record actual locations of valves.

1.6 QUALITY ASSURANCE

- .1 Perform Work to Province of Ontario standards. Maintain one copy on site.
- .2 Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.7 REGULATORY REQUIREMENTS

- .1 Perform Work to Province of Ontario 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.

1.8 DELIVERY, STORAGE, AND PROTECTION

- .1 Accept valves on site in shipping containers with labelling in place. Inspect for damage.
- .2 Provide temporary protective coating on cast iron and steel valves.
- .3 Provide temporary end caps and closures on piping and fittings. Maintain it in place until installation.
- .4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

- .1 Do not install underground piping when bedding is wet or frozen.

1.10 EXTRA MATERIALS

- .1 Provide two repacking kits for each size valve.

2 Products

2.1 SEWER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING

- .1 Cast Iron Pipe: ASTM A74 extra heavy weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- .2 Cast Iron Pipe: CISPI 301, hubless.
 - .1 Fittings: Cast iron.
 - .2 Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.
- .3 Copper Tube: ASTM B306, DWV.
 - .1 Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
 - .2 Joints: ASTM B32, solder, Grade 50B.
- .4 ABS Pipe: ASTM D2751 or ASTM F628.
 - .1 Fittings: ABS.
 - .2 Joints: ASTM D2235, solvent weld.
- .5 ABS Pipe: ASTM D2661 or ASTM D2751.
 - .1 Fittings: ABS.
 - .2 Joints: ASTM D2235, solvent weld.
- .6 PVC Pipe: ASTM D2665 or ASTM D3034.
 - .1 Fittings: PVC.
 - .2 Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- .7 PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679.
 - .1 Fittings: PVC.
 - .2 Joints: ASTM F477, elastomeric gaskets.

2.2 (NIL) SANITARY SEWER PIPING, ABOVE GRADE

- .1 Cast Iron Pipe: ASTM A74, service weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: ASTM C564, neoprene gasket system
- .2 Cast Iron Pipe: CISPI 301, hubless, service weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: CISPI 310, neoprene gaskets and stainless-steel clamp-and-shield assemblies.
- .3 Copper Tube: ASTM B306, DWV.
 - .1 Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper, or ASME B16.32, sovent.
 - .2 Joints: ASTM B32, solder, Grade 50B.

2.3 WATER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING

- .1 Copper Tubing: ASTM B42, hard drawn.

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- .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
 - .2 Joints: AWS A5.8, BCuP silver braze.
 - .2 Copper Tubing: ASTM B42, annealed.
 - .1 Fittings: ASME B16.26, cast bronze.
 - .2 Joints: Flared.
 - .3 Ductile Iron Pipe: AWWA C151.
 - .1 Fittings: Ductile iron, standard thickness.
 - .2 Lining: cement
 - .3 Joints: AWWA C111, rubber gasket with 3/4" (19 mm) diameter rods.

2.4 WATER PIPING, ABOVE GRADE

- .1 Copper Tubing: ASTM B88M, Type L, hard drawn.
 - .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - .2 Joints: ASTM B32, solder, Grade 95TA.
- .2 Copper Tubing: ASTM B88M, Type L, hard drawn.
 - .1 Fittings: Cast iron, coated.
 - .2 Joints: Grooved mechanical couplings.

2.5 (NIL)STORM WATER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING

- .1 Cast Iron Pipe: ASTM A74 extra heavy weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: ASTM C564, neoprene gasket system or lead and oakum.
- .2 Cast Iron Pipe: CISPI 301, hubless, service weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.
- .3 ABS Pipe: ASTM D2680 or ASTM D2751.
 - .1 Fittings: ABS.
 - .2 Joints: ASTM D2235, solvent weld, maximum VOC content of 325 g/L.
- .4 PVC Pipe: ASTM D2665 or ASTM D3034.
 - .1 Fittings: PVC.
 - .2 Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- .5 PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679.
 - .1 Fittings: PVC.
 - .2 Joints: ASTM F477, elastomeric gaskets.

2.6 STORM WATER PIPING, ABOVE GRADE

- .1 Cast Iron Pipe: ASTM A74 extra heavy weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: ASTM C564, neoprene gasket system or lead and oakum.
- .2 Cast Iron Pipe: CISPI 301, hubless, service weight.
 - .1 Fittings: Cast iron.
 - .2 Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.7 FLANGES, UNIONS, AND COUPLINGS

- .1 Pipe Size 3-1/4" (80 mm) and Under:
 - .1 Ferrous pipe: Class 150 malleable iron threaded unions.
 - .2 Copper tube and pipe: Class 150 bronze unions with soldered joints.
- .2 Pipe Size Over 1" (25 mm):
 - .1 Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 - .2 Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

- .3 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.
- .4 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.8 PIPE HANGERS AND SUPPORTS

- .1 Plumbing Piping - Drain, Waste, and Vent:
 - .1 Conform to ASME B31.9.
 - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
 - .3 Hangers for Pipe Sizes 2" (50 mm) 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 3-1/4" (80 mm): Cast iron hook.
 - .6 Wall Support for Pipe Sizes 4" (100 mm) 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.
 - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
 - .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
 - .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
 - .5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
 - .6 Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
 - .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
 - .8 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.
 - .9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
 - .10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe 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 4" (100 mm): Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
 - .14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
 - .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.9 VALVES - GENERAL

- .1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
- .2 Provide valves of the same manufacturer where possible.
- .3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
- .4 Valid CRN (Canadian Registration Number) issued by Province of Ontario required for each valve.
- .5 Materials:
 - .1 Bronze: ASTM B62 or B61 as applicable

.2	Brass:	ASTM B283 C3770
.3	Cast Iron:	ASTM A126 Class B
.6	End Connections:	
.1	Flanged ends:	ANSI B16.1 (Class 125), ANSI B16.5
.2	Face-to-face dimensions:	ANSI B16.10
.7	Design and Testing:	
.1	Bronze Gate & Check valves:	MSS-SP-80
.2	Ball Valves:	MSS-SP-110
.3	Cast Iron Gate Valves:	MSS-SP-70
.4	Cast Iron Globe Valves:	MSS-SP-85
.5	Cast Iron Check:	MSS-SP-71
.6	Butterfly Valves:	MSS-SP-67
.8	First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products listed on spread sheet attached.	

2.10 ISOLATION VALVES

- .1 Up To and Including 2" (50mm) - Ball type
 - .1 Manufacturer: Kitz #69AMLL
 - .2 Construction: MSS SP-110, Class 150, 600 psi (4140 kPa) CWP, forged brass, two piece body, stainless steel ball and stem, full port, virgin PTFE seats and stem packing, blow-out proof stem, lever handle with balancing stops, stem extensions for insulated piping, solder ends.
- .2 2-1/2" (65 mm) and Larger - Butterfly type:
 - .1 Manufacturer: Kitz 6122EL
 - .2 Construction: MSS-SP-67, MSS-SP-25 and API-609; lug type having bi-directional "Dead End Service" pressure rating of 1380 kPa (200 psi) with the downstream flange removed; stainless steel stem with top and bottom bushings of dissimilar materials and with positive stem retention mechanism, aluminum bronze disc and molded or bonded style EPDM seat; suitable for both chilled water and hot water operation; supplied with 10 position locking lever handle 2" extended neck to allow for insulation. Provide gear operators for valves 150 mm and larger, and chain-wheel operators for valves mounted over 8-Ft (2400 mm) above floor.

2.11 THROTTLING VALVES

- .1 Up To and Including 2" (50 mm) - Globe type:
 - .1 Manufacturer: Kitz 10.
 - .2 Construction: MSS SP-80, 860 kPa (125psig) 200 WOG, bronze body to ASTM B62, rising stem, union bonnet, inside screw, PTFE disk, solder ends.
- .2 2-1/2" (65 mm) and Larger - Globe type:
 - .1 Manufacturer: Kitz 76 (Globe)
 - .2 Construction: Cast iron body globe
- .3 2-1/2" (65 mm) and Larger - Butterfly type
 - .1 Manufacturer: Kitz 6122EL
 - .2 Construction: MSS-SP-67, MSS-SP-25 and API-609; lug type having bi-directional "Dead End Service" pressure rating of 1380 kPa (200 psi) with the downstream flange removed; stainless steel stem with top and bottom bushings of dissimilar materials and with positive stem retention mechanism, aluminum bronze disc and molded or bonded style EPDM seat; suitable for both chilled water and hot water operation; supplied with 10 position locking lever handle 2" extended neck to allow for insulation. Provide gear operators for valves 150 mm and larger, and chain-wheel operators for valves mounted over 8-Ft (2400 mm) above floor.

2.12 CHECK VALVES

- .1 Up To and Including 3" (75 mm):
 - .1 Manufacturers: Kitz 23
 - .2 Construction: MSS SP-80, 860 kPa (125psig) 200 WOG, bronze body to ASTM B62, bronze trim, solder ends
- .2 4" (100mm) and Larger:
 - .1 Manufacturers: Kitz 78
 - .2 Construction: MSS SP-71, 1380 kPa Class 125 / 200 WOG, Cast iron body to ASTM A126 Class B, Bronze trim, Bolted Bonnet, flanged ends.

2.13 DRAIN VALVES

- .1 Up to 150 psig - Ball type:
 - .1 Manufacturers: Kitz 68C
 - .2 Construction: 150 psig (1034 kPa), 600 WOG, brass body to ASTM C37700, two piece body, full port, PTFE seats and stem packing or double "O" ring, blow-out proof stem, Chrome Plated ball, lever handle with cap and chain, (3/4") 20 mm hose connection.

2.14 WATER PRESSURE REDUCING VALVES

- .1 Up to 2" (50 mm):
 - .1 Manufacturers:
 - .1 Armstrong Model GD 24.
 - .2 Watts Model Series 223.
 - .3 Substitutions: Refer to Section 01 62 00.
 - .2 MSS SP-80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded ends.
- .2 Over 2" (50 mm):
 - .1 Manufacturers:
 - .1 Armstrong Model GD 200.200H.
 - .2 Watts Model Series N223.
 - .3 Substitutions: Refer to Section 01 62 00.
 - .2 MSS SP-85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.15 RELIEF VALVES

- .1 Pressure Relief:
 - .1 Manufacturers:
 - .1 Watts Model Series 40.
 - .2 Substitutions: Refer to Section 01 62 00.
 - .2 AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

2.16 STRAINERS

- .1 Up to 125 psig:
 - .1 Size 2" (50 mm) and Under:
 - .1 Manufacturers: Mueller Steam 351M
 - .2 Construction: 860 kPa (125 psig) 200 WOG Rating, Bronze body, Screwed Cap, Y Pattern, 304 stainless steel screen with 20 Mesh perforation, Threaded Ends.
 - .2 Size 2-1/2" (65 mm) and larger:
 - .1 Manufacturers: Mueller Steam 758
 - .2 Construction: 860 kPa (125 psig)/ 200 WOG Rating, Cast Iron body, Bolted Cover, Y Pattern, 304 stainless steel screen with 1/16 & 1/8 perforation, Threaded Ends.
- .2 Up to 250 psig:

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- .1 Size 2" (50 mm) and Under:
 - .1 Manufacturers: Mueller Steam 11M
 - .2 Construction: Class 250, 400 psig WOG, cast iron body, Y-pattern, screwed cap and ends, A167 304 stainless steel screen with 1/32" perforations.
 - .2 Size 2-1/2" (65 mm) and larger:
 - .1 Manufacturers: Mueller Steam 758
 - .2 Construction: 300 psig non-shock WOG, cast iron, Y-pattern, bolted cover, blow-out plug, A167 304 stainless steel screen with 1/32" perforations, flanged ends.

2.17 DISINFECTION CHEMICALS

- .1 Chemicals: AWWA B300, Hypochlorite,

3 Execution

3.1 EXAMINATION

- .1 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 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.
- .7 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- .8 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with general trades.
- .9 Establish elevations of buried piping outside the building to ensure not less than 4' (1.2 m) of cover.
- .10 Install vent piping penetrating roofed areas to maintain integrity of roof assembly; refer to Division 07.
- .11 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (maximum VOC content of 80 g/L) to welding.
- .12 Provide support for utility meters to requirements of utility companies.
- .13 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting where required. Coordinate with general trades.
- .14 Excavate and backfill as required 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 Sleeve pipes passing through partitions, walls and floors.
- .19 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 4" mm).
- .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

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- .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
 - .20 Pipe Hangers and Supports:
 - .1 Install to OBC (Plumbing Code)
 - .2 Support horizontal piping as scheduled.
 - .3 Install hangers to provide minimum 1/2" (15 mm) space between finished covering and adjacent work.
 - .4 Place hangers within 12" (300 mm) of each horizontal elbow.
 - .5 Use hangers with 1-1/2" (40 mm) 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.
 - .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.
 - .11 Support cast iron drainage piping at every joint.

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 gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- .5 Install globe 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 ERECTION TOLERANCES

- .1 Establish invert elevations, slopes for drainage to 2 percent minimum. Maintain gradients.
- .2 Slope water piping minimum 0.25 percent and arrange to drain at low points.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- .1 Disinfect all new and altered water distribution piping.
- .1 Verify that piping system is complete and has been flushed, cleaned, inspected, and pressure tested.
- .2 Isolate existing piping to full extent possible. Ensure that all fixtures, existing and new that are served from piping being disinfected, are taken out of service and signs are placed at each fixture prohibiting use during the disinfection period.
- .2 Schedule and perform disinfecting activities with start-up, testing, adjusting, balancing, and demonstration procedures. Coordinate with related systems.
- .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 percent of outlets.
- .6 Maintain disinfectant in system for 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 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze to AWWA C651.

3.7 SERVICE CONNECTIONS

- .1 Provide new sanitary 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 reduced pressure backflow preventer and water meter with by-pass valves pressure reducing valve.
- .3 Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 1.75 kPa. Provide regulators on each line serving gravity type appliances, sized to equipment.

3.8 SCHEDULES

- .1 Pipe Hanger Schedule:
 - .1 Metal Piping:
 - .1 Pipe size: 1/2" to 1-1/4" (15 to 32 mm):
 - .1 Maximum hanger spacing: 6.5' (2 m).
 - .2 Hanger rod diameter: 3/8" (9 mm).
 - .2 Pipe size: 1-1/2" to 2" (40 to 50 mm):
 - .1 Maximum hanger spacing: 10' (3 m).
 - .2 Hanger rod diameter: 3/8" (9 mm).
 - .3 Pipe size: 2-1/2" to 3" (65 to 75 mm):
 - .1 Maximum hanger spacing: 10' (3 m).
 - .2 Hanger rod diameter: 1/2" (13 mm).
 - .4 Pipe size: 4" to 6" (100 to 150 mm):
 - .1 Maximum hanger spacing: 10' (3 m).
 - .2 Hanger rod diameter: 1/2" (15 mm).
 - .5 Pipe size: 8" to 12" (200 to 300 mm):
 - .1 Maximum hanger spacing: 14' (4.25 m).
 - .2 Hanger rod diameter: 3/4" (22 mm).
 - .6 Pipe size: 14" (350 mm) and Over:
 - .1 Maximum hanger spacing: 20' (6 m).
 - .2 Hanger rod diameter: 1" (25 mm).

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

- .1 Roof and floor drains.
- .2 Cleanouts.
- .3 Hose bibs.
- .4 NIL(Not in List)
- .5 Backflow preventers.
- .6 Water hammer arrestors.
- .7 NIL.
- .8 Trap Seal Primers.
- .9 Oil Interceptor

1.3 REFERENCES

- .1 ASME A112.21.1 - Floor Drains.
- .2 ASME A112.21.2 - Roof Drains.
- .3 ASME A112.26.1 - Water Hammer Arrestors.
- .4 ASSE 1011 - Hose Connection Vacuum Breakers.
- .5 ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
- .6 ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
- .7 AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
- .8 PDI WH-201 - Water Hammer Arrestors.

1.4 SUBMITTALS FOR REVIEW

- .1 Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- .2 Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1.5 SUBMITTALS FOR INFORMATION

- .1 Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.
- .2 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND PROTECTION

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

2 Products

2.1 ROOF DRAINS

- .1 Built - Up Roofs
- .1 Manufacturer: Watts Drainage Model RD100-BED-W-1.
- .2 Assembly: ANSI A112.21.2.

- .3 Body: Lacquered cast iron with sump.
- .4 Strainer: Removable polyethylene dome with vandal proof screws.
- .5 Accessories: Coordinate with roofing type, refer to Division 7:
- .1 Membrane flange and membrane clamp with integral gravel stop.
- .2 Adjustable under deck clamp.
- .3 Roof sump receiver.
- .4 Adjustable extension sleeve for roof insulation

2.2 FLOOR DRAINS

- .1 Floor Drain (FD):
 - .1 Watts Drainage model FD-100-C-5
 - .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable round nickel-bronze strainer with removable perforated sediment bucket.
- .2 Floor Drain (FFD):
 - .1 Watts Drainage Model FD-100-C-EG
 - .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze elongated funnel.
- .3 Floor Drain (HD):
 - .1 Watts Drainage Model FD-100-C-AS-7-8
 - .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, adjustable nickel-bronze angle strainer, trap primer tapping, and backwater valve.

2.3 TRAP SEAL PRIMERS

- 1. Individual Traps:
 - 1. Watts Drainage model MS-810
 - 2. Automatic cast brass body, renewable disc and seat rings, vacuum breaker and removable cover.
- 2. Groups of Traps:
 - 1. PPP Inc. Oregon #1 complete with supply tube and/or distribution units. Primer suitable for up to 8 drains.

2.4 CLEANOUTS

- .1 Exterior Surfaced Areas:
 - .1 Watts Drainage model CO-200-RFC
 - .2 Round cast nickel bronze access frame and non-skid cover.
- .2 Exterior Unsurfaced Areas:
 - .1 Watts Drainage model CO-300-MF
- .2 Extra Heavy-Duty type with epoxy coated cast iron body with two fixed anchor flanges and round heavy duty ductile iron gasketed cover.
- .3 Interior Finished Floor Areas:
 - .1 Watts Drainage model CO-200-R, CO-200-U
 - .2 Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
- .4 Interior Finished Wall Areas:
 - .1 Watts Drainage model WUCO
 - .2 Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
- .5 Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.
- .6 Line Cleanouts: lacquered cast iron Malcom type with cleanout ferrule, 1/2" (13mm) thick epoxy coated gasketed cover.
- .7 Caulking for cleanouts: VOC content not to exceed 250g/L

2.6 HYDRANTS

- .1 Exterior Wall Hydrant, (H-1):
 - .1 Watts Drainage model HY-725
 - .2 ANSI/ASSE 1019; non-freeze, self-draining type with polished nickel bronze box and cover for recessed mounting, all bronze head, seat casting and internal working parts, 3/4" (20 mm) hose thread spout, key operated, integral vacuum breaker, galvanized wall casing and hydrant key.
- .2 Interior Wall Hydrant, (H-2):
 - .1 Watts Drainage model HY-330
 - .2 ANSI/ASSE 1019; self-draining type with polished nickel bronze box and cover for recessed mounting, all bronze head, seat casting and internal working parts, 3/4" (20 mm) hose thread spout, key operated, integral vacuum breaker, galvanized wall casing and hydrant key.

2.7 BACKFLOW PREVENTERS

- .1 Reduced Pressure Backflow Preventers:
 - .1 Manufacturers:
 - .1 Watts Model 909.
 - .2 ITT lawler Model RZ.
 - .3 Baukman Model BF-299.
 - .4 Febco Model 825Y
 - .4 Substitutions: Refer to Section 01 62 00.
 - .2 ANSI/ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

2.8 WATER HAMMER ARRESTORS

- .1 Watts Drainage Series 05
- .2 ANSI A112.26.1; copper construction, piston type sized to PDI WH-201, precharged suitable for operation in temperature range 99°F to 300°F (-73°C to 149°C) and maximum 150 psi (1000 kPa) working pressure.

2.9 OIL/ GREASE INTERCEPTOR

- .1 Watts Drainage OI-625
- .2 Oil interceptor with extra heavy-duty cover and extension storage tank as required.

3 Execution

3.1 GENERAL

- .1 Install all products in accordance with the plumbing code and with manufacturer's instructions.

3.2 CLEANOUTS

- .1 Cleanouts shall be the same size as the pipe up to 4" (100mm) and not less than 4" (100mm) for larger pipes.
- .2 Provide cleanouts at the end of mains and branches, at changes in direction, in long straight runs and at the base of all soil stacks and rainwater leaders and where required by code.
- .3 Extend cleanouts to finished floor or wall surface.
- .4 Encase exterior cleanouts in concrete flush with grade.
- .5 Install floor cleanouts at elevation to accommodate finished floor.
- .6 Cleanouts in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.
- .7 Lubricate threaded cleanout plugs with mixture of graphite and linseed oil.
- .8 Ensure clearance at cleanout for rodding of drainage system.

3.3 FLOOR DRAINS

- .1 Provide floor drains where indicated on architectural and plumbing floor plans.
- .2 Inspect locations where floor drains are shown to determine that floor is sloped appropriately. Report concerns to Consultant prior to installation of drains.
- .3 Coordinate installation with general trades.
- .4 Trap and vent all floor drains in accordance with Plumbing Code.
- .5 Provide trap seal priming for each floor drain trap.
- .6 Floor drains in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.
- .7 Floor drains, traps and drain pipes installed in slabs on grade shall be embedded in concrete and made water-tight to prevent water seepage.

3.4 ROOF DRAINS

- .1 Locate roof drains where indicated on roofing plans.
- .2 Inspect locations where roof drains are shown to determine that roof is sloped appropriately. Report concerns to Consultant prior to installation of drains.
- .3 Coordinate installation with roofing trade.

3.5 WALL HYDRANTS

- .1 Locate wall hydrants where indicated.
- .2 Coordinate installation with general trades.

3.6 WATER HAMMER ARRESTORS

- .1 Install water hammer arrestors complete with an accessible isolation valve on hot and cold water supply piping to;
 - .1 plumbing fixtures and fixture groups,
 - .2 Owner's equipment and appliances with flush valves, solenoid valves or other quick closing valves,
 - .3 Downstream of each backflow preventer,
 - .4 Wherever necessary to prevent water hammer.

3.7 TRAP SEAL PRIMERS

- .1 Traps may be primed from the flush tube of a flush valve or from the waste of a drinking fountain.
- .2 No more than three (3) traps may be primed from one flush valve or one drinking fountain.
- .2 Condensate drains from cooling units may not be used to prime traps.
- .3 Trap seal primers shall be provided where flush valves and/or drinking fountains are not available.
- .4 Group trap primers shall be provided where specifically shown and where agreed with the Consultant.

3.8 BACKFLOW PREVENTION

- .1 Backflow prevention includes backflow preventers, anti-siphon devices and vacuum breakers.
- .2 Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur;
 - .1 on boiler feed water lines,
 - .2 housekeeping faucets,
 - .3 fire sprinkler systems,
 - .4 premise isolation,
 - .5 irrigation systems,
 - .6 flush valves,
 - .7 interior and exterior wall hydrants (hose bibs).
 - .8 Where require by codes, regulations and/or standards.
- .3 Pipe relief or drain from backflow prevention device to nearest drain.
- .4 Install a strainer upstream of each backflow preventer.

3.9 INTERCEPTORS

- .1 Install interceptors so as to be accessible for cleaning and all other maintenance and repair which may be required.
- .2 Make all piping connections. Vent in accordance with Plumbing Code.
- .3 Fill with appropriate media as required and turn over spare media to Owner.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

- .1 Water closets, seats, tanks, flush valves, supplies, carriers
- .2 Urinals, tanks, flush valves
- .4 Lavatories, faucets, spouts, waste, carriers
- .5 Stainless steel sinks, faucets, spouts,
- .6 Service sinks, traps, faucets, spouts, accessories

1.3 REFERENCES

- .1 ANSI Z124.1 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Bathtub Units.
- .2 ANSI Z124.2 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Shower Receptor and Shower Stall Units.
- .3 ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.
- .4 ARI 1010 - Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- .5 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- .6 ASME A112.18.1 - Plumbing Fixture Fittings.
- .7 ASME A112.19.1 - Enamelled Cast Iron Plumbing Fixtures.
- .8 ASME A112.19.2 - Vitreous China Plumbing Fixtures.
- .9 ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- .10 ASME A112.19.4 - Porcelain Enamelled Formed Steel Plumbing Fixtures.
- .11 ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

1.4 SUBMITTALS FOR REVIEW

- .1 Product Data:
 - .1 Provide catalogue illustrations of fixtures,
 - .2 sizes,
 - .3 rough-in dimensions,
 - .4 service sizes (capacities)
 - .5 trim,
 - .6 finishes.

1.5 SUBMITTALS FOR INFORMATION

- .1 Manufacturer's Instructions: Indicate installation methods and procedures.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- .2 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum five years documented experience.
- .2 Installer Qualifications: trades licence with minimum five years documented experience.

1.8 DELIVERY, STORAGE, AND 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.

2 Products

2.1 MANUFACTURERS

- 1. All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.
- 2. Vitreous China fixtures:
 - .1 Manufacturer: American Standard.
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Crane
 - .2 Kohler
 - .3 Toto
 - .4 Eljer
- 3. Stainless Steel fixtures:
 - .1 Manufacturer: Acorn.
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Bradley
 - .2 Willoughby
- 4. Seats
 - .1 Manufacturer: Centoco
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Benecke
 - .2 Olsonite
 - .3 Kohler
 - .4 Bemis
- 5. Mechanical Flush Valves
 - .1 Manufacturer: Sloan
 - .2 Other acceptable manufacturers offering equivalent products:
 - .1 Zurn
 - .2 Cambridge Brass
 - .3 Powers
- 6. Diverter Valves
 - .1 Manufacturer: Powers
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Kohler
 - .4 Sloan
- 7. Carriers
 - .1 Manufacturer: Watts Ancon
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Zurn
 - .2 J. R. Smith
 - .3 MIFAB

2.2 WATER CLOSET WALL HUNG- FLUSHOMETER – EXPOSED – MANUAL (W-2) (BF)

1. **American Standard Wall hung toilet MODEL 3351101.020.** Toilet operates in the range of 4.2 to 6.0 LPF (1.1- 1.6 GPF), White finish Vitreous china, EverClean® antimicrobial surface, Elongated bowl, Concealed trapway design, Direct-fed siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, Fully-glazed 54 mm (2-1/8") trapway, Static load rating of 454 kg (1000 lb), this product is not recommended for bariatric use, Condensation channel, Toilet seat not included, Consisting of: Overall Dimensions: 356 mm (14") wide, 660 mm (26") from finished wall, Water Surface: 254 x 305 mm (10" x 12") water surface area, Compliances: ASME A112.19.2 compliant, CSA B45.1 compliant.
2. **Centoco #500STSCFE-001 FAST-N-LOCK,** for elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish,
3. **Sloan ROYAL #111-1.1,** exposed manual Flushometer for Top Spud toilet, chrome plated, 6L (1.6 US Gal) factory set flow, quiet action diaphragm type, non-hold open feature, A. D. A oscillating handle, back-check angle stop (screwdriver operated), flush tube for 292mm (11-1/2") rough-in, vacuum breaker.
4. **Carrier Watts-ISCA-101-L/R-AUX-3** Horizontal, Industry Standard Horizontal adjustable Closet Carrier single w/Aux inlet, 500 lb. (227 kg.), Adjustable for standard and wheelchair height, 2-1/8" bend auxiliary inlet, 102 mm (4") no hub waste, 51 mm (2") no hub vent connections, patent pending compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple, 3" no Hub Fitting,

2.3 WATER CLOSET FLOOR MOUNTED- FLUSHOMETER – EXPOSED – MANUAL (W-1)

1. **American Standard Madera Flowise Elongated 381mm high #3451.001.020 HET Toilet,** white vitreous china with EverClean antimicrobial surface which inhibits the growth of stain and odor causing bacteria mold and mildew, floor mounted, siphon jet flush action, operates in the range of 4.2L to 4.8L per flush, condensate channel, 305mm x 254mm (12" x 10"), 54mm (2-1/8") fully glazed internal trapway, floor outlet, bolt caps, 38mm (1-1/2") dia. Top spud.
2. **Centoco #500STSCC.001 heavy duty toilet seat,** for elongated bowl open front, white solid plastic, less cover, reinforced stainless steel check hinges, metal flat washers stainless steel posts and nuts. **Sloan Regal #111-XL-CP,** exposed manual Flushometer for Top Spud toilet, chrome plated, 6L (1.6 US Gal) factory set flow, quiet action diaphragm type, non-hold open feature, A. D. A oscillating handle, back-check angle stop (screwdriver operated), flush tube for 292mm (11-1/2") rough-in, vacuum breaker.
3. **Provide Floor Flange,** (same material as the connecting pipe drain), with all brass bolts and with rubber gasket

2.5 WALL HUNG LAVATORY – TWO HANDLE FAUCET (L-2) (BF)

1. **American Standard Murro with Ever clean #0954.004EC/0059.020EC Basin,** 540mm x 520mm x 165mm (21-1/4" x 20-1/2" x 6-1/2") high, vitreous china, for carrier with concealed arms, rear overflow, recessed self-draining faucet ledge, **semi-pedestal P-trap cover.**
2. **Chicago Faucets #802-VCP-317VP-XK-E2805 Two handle faucet,** 4" (102mm) centerset, solid brass body construction, ceramic 1/4 turn cartridge, with Vandal Resistant 1.9LPM (0.5 GPM), aerator outlet, metal red and blue index buttons 102mm (4") long wrist blade handle with vandal resistant screw.
3. **McGuire #155AC open grid drain,** chrome plated cast brass one piece top, 1.5mm (1/16") tubular 32mm (1-1/4") tailpiece.
4. **McGuire #H170BVRB Faucet Supplies,** chrome finish polished brass, 13mm (1/2") I. D. Inlet x 127mm (5") horizontal extension tubes, combination V. P. Loose key handle, escutcheon and stainless steel braided flexible riser.
5. **McGuire #8872C P-Trap,** heavy cast brass adjustable body, with slip nut, 32mm (1-1/4") size, shallow wall flange and seamless tubular wall bend.
6. **Watts #TCA-411, Carrier,** mounted on concrete floor, with epoxy coated cast iron concealed arms with sliding adjustable arm brackets, heavy gauge steel uprights with integral welded feet. Minimum space required: for one unit: 102mm (4") for two to six units in a row: 152mm (6") finished metal stud wall to

back of pipe space.

2.6 COUNTER MOUNTED LAVATORY- TWO HANDLE FAUCET (L1)

1. **American Standard Aqualyn #0476.028 Basin**, 518mm x 441mm x (20-3/8" x 17-3/8" x 7") high, oval, vitreous china, self-rimming - drop-in, front overflow, faucet ledge, tapered edges.
2. **Chicago Faucets #802-VCP-369VP-XK-E2805 Two handle faucet**, 4" (102mm) centerset, solid brass body construction, ceramic 1/4 turn cartridge, with Vandal Resistant 1.9LPM (0.5 GPM), aerator outlet, metal red and blue index buttons 102mm (4") long lever wrist handle with vandal resistant screw.
3. **McGuire #155AC open grid drain**, chrome plated cast brass one piece top, 1.5mm (1/16") tubular 32mm (1-1/4") tailpiece.
4. **McGuire #H170BV Faucet Supplies**, chrome finish polished brass, 13mm (1/2") I. D. Inlet x 127mm (5") horizontal extension tubes, combination V. P. Loose key handle, escutcheon and flexible copper riser.
5. **McGuire #8872C P-Trap**, heavy cast brass adjustable body, with slip nut, 32mm (1-1/4") size, shallow wall flange and seamless tubular wall bend.

2.7 BUILT ON SITE SHOWER- SHOWER VALVE AND HEAD (SH1)

1. **Chicago Faucets #1902-CP Shower Valve**, solid brass body construction, pressure balancing, washerless ceramic drip-free disc valve cartridge, metal wall escutcheon, 4.7LPM maximum flow rate '620A' ball joint showerhead with arm and flange.
2. **Watts #FD-100-A, Floor Drain**, 2" (51mm) outlet, epoxy coated cast iron, anchor flange, adjustable round nickel bronze strainer, reversible clamping collar with primary & secondary weepholes.
3. **Provide P-Trap**, same material as the connecting pipe drain.

2.8 BARRIER FREE SHOWER (SH2) - VALVE AND HANDSHOWER

1. **Chicago Faucets #SH-PB1-00-000/151-WB-WS**, pressure balancing, washerless ceramic drip-free disc valve cartridge, metal wall escutcheon. **Comply with local codes for Shower Control location and Trim Kit requirements.**
2. **Chicago Faucets #151-VB-WS Commercial hand shower slide bar, 24" (610 mm)**, 4.7 LPM maximum flow rate, spray head, 60" (1524 mm) flexible metal hose, wall supply elbow with flange, in-line vacuum breaker.
3. **Watts #FD-100-C-A Floor Drain**, epoxy coated cast iron, anchor flange, 5" (127 mm) adjustable round nickel bronze strainer, reversible clamping collar with primary & secondary weepholes.
4. **Provide P-Trap**, same material as the connecting pipe drain.

2.9 DOUBLE BOWL KITCHEN SINK (S1)

1. **Franke Commercial # LBD6408P-1-1** Double bowl – countertop mounted sink –Single hole centerset, With faucet ledge, 18 gauge Type 304 Stainless steel, Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, standpipe with guard, 89 mm (3-1/2") crumb cup strainer, Undercoated to reduce condensation and resonance, Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimension: Left bowl is 356 mm (14") long and right bowl is 356 mm (14") long, Left bowl is 406 mm (16") wide and right bowl is 406 mm (16") wide, Left bowl is 203 mm (8") deep and right bowl is 203 mm (8") deep, Overall Dimension: 794 mm (31-1/4") long, 521 mm (20-1/2") wide, 203 mm (8") high.
2. **Chicago Faucet #1100-ABCP-GN2FC-1000VP-XK two handle manual faucet**, 8" centerset, lead free chrome plated solid brass body, ceramic 1/4 turn cartridges, 5 3/8" rigid/swing gooseneck spout, 1.6GPM max. flow pressure compensating for laminar outlet, plain spout end. Metal red and blue index buttons 2" long canopy lever handles with vandal resistant screw.
3. **Provide Faucet Supplies**, chrome plated all metal construction, light duty residential angle stops, escutcheons and metal flexible risers.
4. **Provide P-Trap**, adjustable all metal construction, 1 1/2" size, with cleanout and escutcheon.

2.10 SERVICE SINK (MS)

1. **Stern Williams #SB-900 square service / Mop sink**, 610mm (24") x 610mm (24") x 305mm (12") deep,

- floor mounted, terrazzo composed of pearl gray marble chips and Portland cement ground smooth, sealed to resist stain, one piece stainless steel cast integral on all sides, without tiling flange, cast brass drain with stainless steel strainer, 3" (75mm) outlet.
2. **Chicago Faucets #305VB-XK-369VP wall mounted Two handle manual faucet, 8" (203mm)** centerset, solid brass exposed body construction, ceramic 1/4 turn cartridge, unrestricted hose end outlet, with body-mounted vacuum breaker, metal red and blue index buttons 60mm (2-3/8") long lever handle with vandal resistant screw.
 3. **Stern Williams T-35 Hose and Wall Hook** hose 36" (914mm) long with 3/4" (19mm) chrome coupling, stainless steel wall bracket. **Stern Williams T-40 Mop Hanger** stainless steel #4 finish, 24" (610mm) long with 3 rubber spring loaded clips. **Stern Williams BP-224 Back Splash Panel** 20 gauge type 304 stainless steel. **Stern Williams TC-3 Gasket** 3" (76mm) for XHCl, plastic and steel pipe.
 4. **Provide P-Trap**, same material as the connecting pipe drain.

2.11 DOUBLE BOWL SCULLERY SINK (LS) (LAUNDRY ROOM)

1. Sink supplied by others and installed by Mechanical Division.
2. **Delta Tech Commercial Pre rinse Faucet #55T1513 Two handle manual faucet, 8" (203mm)** center set, wall mount faucets, spray with spring loaded SS hose Auto shut off with add on faucet (S-5) 1.5 USGPM (5.7 L/min) Aerator and 3" lever blades. Provide 2 set of faucets.
3. **McGuire #8912CB P-Trap**, heavy cast brass adjustable body, with slip nut, 38mm (1-1/2") size, box flange and seamless tubular wall bend.

2.12 EMERGENCY EYE WASH WALL HUNG (EW1)

1. **Guardian #G1750**, Wall Mounted, eye/face wash, 11-1/2" (292 mm) diameter, stainless steel bowl, two (2) FS-Plus spray heads with fliptop dust cover and filter, powder coated cast aluminum flag handle activation, 1/2" (13 mm) IPS chrome plated brass stay-open ball valve with Teflon seal heavy duty cast aluminum wall bracket with corrosion resistant powder coated finish, 1-1/4" (32 mm) NPT female outlet - Unit s third party certified by IAPMO to meet ANSI Z358.1-2014, the Uniform Plumbing Code cUPC and the National Plumbing Code of Canada. **Eyewash/Facewash fixture should be installed 4 to 10 feet from the mixing valve.**
2. **McGuire #8872C P- Trap**, heavy cast brass adjustable body, with slip nut, 32 mm (1-1/4") size, shallow wall flange and seamless tubular wall bend. **Watts #FD-100-C-A Floor Drain**, epoxy coated cast iron, anchor flange, 5" (127 mm) adjustable round nickel bronze strainer, reversible clamping collar with primary & secondary weepholes.
3. **Thermostatic mixing valve**
For Thermostatic Mixing Valve, Lawler model # 911E/F lead-free brass and stainless steel design, vandal-resistant temperature adjustment, stainless steel sliding piston control device allow cold flow through both the fixed and variable bypass, 13 mm (1/2") N.P.T. Outlet, positive hot water shut-off, liquid-filled thermostatic motor control mechanism, 29 °C (84.2 °F) factory set temperature, standard 21 °C (69.8 °F) - 32 °C (89.6 °F) temperature range, 26 LPM (6.9 GPM) flow capacity at 30 psi (207 kPa) pressure drop across the valve, 7.57 LPM (2.0 GPM) min. Flow rate, 18 LPM (4.8 GPM) bypass flow rate at 30 psid. (See 911E/F)

2.13 DECONTAMINATION SINK

1. **Franke commercial – Sink SSU2-2040-7MOD-1**, Single hole centerset, Anti-Microbial Coating, Without faucet ledge, 16-gauge Type 304 Stainless steel Polished to #4 satin finish, With backsplash, Radius coved bowl corners, Access panel for service and maintenance, Includes wall hanger brackets, Center waste location, 38 mm (1-1/2"-16) threaded tailpiece with special integral waste design to prevent use of waste plug, Compliances and certifications: ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimension: 953 mm (37-1/2") long, 343 mm (13-1/2") wide, 254 mm (10") deep, Overall Dimension: 1016 mm (40") long, 502 mm (19-3/4") wide, 711 mm (28").
2. **Chicago Faucets – Faucet, 116.104.AB.1 HYTRONIC®**, Wall-hung, Automatic no-touch, Hardwired, Sink/lavatory faucet, Polished chrome finish, Single hole centerset, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant ECAST® brass construction, Stainless steel hoses included, 1.9 LPM (0.5 GPM) maximum flowrate, Pressure compensating non-aerated laminar spray outlet, includes optional 5.7 LPM (1.5 GPM) insert, Rigid/swing Gooseneck spout, 138 mm (5-3/8") spout reach, 305 mm (12") high, Less handles, Dual infrared sensor, 12 volt AC

transformer required (to be ordered separately).

3. 240.630.00.1 Plug-In AC transformer

4. Lawler - Mixing Valve, **570-86820** Point of Use and Master controlled fixtures, Thermostatic master water mixing control valve, The temperature is adjusted with the help of Spindle.

3 Execution

3.1 EXAMINATION AND PREPARATION

- .1 Section 22 01 01: Verification of 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.

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 each fixture with trap, easily removable for servicing and cleaning.
- .2 Provide chrome plated rigid supplies to fixtures with screwdriver stops, reducers, and escutcheons.
- .3 Install components level and plumb.
- .4 Install and secure floor mounted fixtures in place with bolts.
- .4 Install and secure wall hung fixtures in place with wall carriers and bolts.
- .5 Seal fixtures to wall and floor surfaces with sealant having VOC content not exceeding 250 g/L, colour to match fixture.
- .6 Solidly attach water closets to floor with lag screws.

3.4 ADJUSTING

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

3.5 CLEANING

- .1 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

- .1 Do not permit use of fixtures.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

- .1 Electric Domestic Water Heater
- .2 Domestic Hot Water Re-Circulation Pump.

1.3 RELATED SECTIONS

- .1 Section 22 01 01 - Administrative Requirements.

1.4 REFERENCES

- .1 ASHRAE 90A - Energy Conservation in New Building Design.
- .2 ASME Section 8D - Boilers and Pressure Vessel Codes - Rules for Construction of Pressure Vessels.

1.5 SUBMITTALS FOR REVIEW

- .1 Procedures for submittals.
- .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 heat exchanger dimensions, size of tapings, and performance data.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Procedures for submittals.
- .2 Project Record Documents: 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: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Provide pumps with manufacturer's name, model number, and rating/capacity identified.
- .3 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).

- .4 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.8 REGULATORY REQUIREMENTS

- .1 Conform to ASME Section 8D for manufacture of pressure vessels for heat exchangers.
- .3 Conform to ASME Section 8D for tanks.
- .4 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 22 01 01: Transport, handle, store, and protect products.
- .2 Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.10 WARRANTY

- .1 Section 22 01 01.
- .2 Provide five year manufacturer warranty for domestic water heaters packaged water heating systems in-line circulator.

1.11 EXTRA MATERIALS

- .1 Section 22 01 01.
- .2 Provide two pump seals.

2 Products

2.1 ELECTRIC DOMESTIC WATER HEATERS

- .1 Manufacturer: A.O. Smith
- .2 Other acceptable manufacturers offering equivalent products.
 - .1 Rheem
 - .2 John Wood
 - .3 Bradford White

2.2 DHW RECIRCULATION PUMP P-1

- .1 Manufacturer: Astro Model 230SS 6 USGPM @12FT HEAD, 97W 115 V – 1 PHASE
- .2 Equivalent products by other manufacturers

2.3 EXPANSION TANK

- .1 Manufacturer: Watts DETA-42
- .2 Equivalent products by other manufacturers

3 Execution

3.1 INSTALLATION

- .1 Install water heaters to the manufacturer's instructions and to AGA requirements.
- .2 Coordinate with plumbing piping and related fuel piping work to achieve operating system.
- .3 Domestic Water Heat Exchangers:
 - .1 Install domestic water heat exchangers with clearance for tube bundle removal without

-
- disturbing other installed equipment or piping.
 - .2 Support unit on pipe stand.
 - .3 Pipe relief valves and drains to nearest floor drain.
 - .4 Connect steam branch line from top of main. Pipe in flexible manner, pitched with steam flow, with pipe union connections. Provide steam pressure gauge at exchanger inlet.
 - .5 Provide steam traps and valves as indicated.
 - .6 Pitch shell for condensate drain to traps.
 - .4 Domestic Hot Water Storage Tanks:
 - .1 Provide steel pipe support, independent of building structural framing members.
 - .2 Clean and flush prior to delivery to site. Seal until pipe connections are made.
 - .5 DHW Re-Circulation Pump: P-1
 - .1 Install re-circulation pump as per manufacturers installation instructions.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

- .1 Pipe and pipe fittings.
- .2 Valves.
- .3 Accessories.

1.3 REFERENCES

- .1 ANSI B31.1 - Power Piping.
- .2 ANSI B31.9 - Building Service Piping.
- .3 ASME SEC IX - Welding and Brazing Qualifications.
- .4 ASME B16.3 - Malleable Iron Threaded Fittings.
- .5 ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- .6 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .7 NFPA 31 - Installation of Oil-Burning Equipment.

1.4 SUBMITTALS FOR REVIEW

- .1 Section 22 01 01: Procedures for submittals.
- .2 Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.5 SUBMITTALS FOR INFORMATION

- .1 Contractor's material and test certificates.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Section 22 01 01: Procedures for submittals.
- .2 Project Record Documents: Record actual locations of piping system, storage tanks, and system components.
- .3 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- .4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

- .1 Welding Materials and Procedures: Conform to ASME Code.
- .2 Welders Certification: To ASME SEC IX.
- .3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .4 Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.
- .5 Valves: Manufacturer's name and pressure rating marked on valve body.

1.8 REGULATORY REQUIREMENTS

- .1 Conform to CSA B149.1 Natural Gas and Propane installation code
- .2 Conform to ANSI B31.1 for installation of fuel oil piping.
- .3 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 22 01 01: Transport, handle, store, and protect products.
- .2 Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation.

1.10 WARRANTY

- .1 Section 22 01 01.

1.11 EXTRA MATERIALS

- .1 Section 22 01 01.
- .2 Provide two repacking kits for each size valve.

2 Products

2.1 BURIED PIPING

- .1 Copper Tubing: ASTM B88M, Type K,
 - .1 Fittings: ASME B16.18, cast copper alloy or ASTM B16.22 wrought copper or bronze.
 - .2 Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.
- .2 Copper Tubing: ASTM B88M, Type K, annealed.
 - .1 Fittings: ASME B16.26, cast bronze.
 - .2 Joints: Flared.
- .3 Steel Pipe: ASTM A53, Schedule 40 black.
 - .1 Fittings: ASTM A234/A234M, wrought carbon steel and alloy steel welding type.
 - .2 Joints: ANSI B31.1 welded.
 - .3 Jacket: AWWA C105 polyethylene or double layer, half-lapped 0.25 mm polyethylene tape.

2.2 ABOVE GROUND PIPING

- .1 Copper Tubing: ASTM B88M, Type K, hard drawn.
 - .1 Fittings: ASME B16.18, cast copper alloy or ASTM B16.22 wrought copper and bronze.
 - .2 Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.
- .2 Copper Tubing: ASTM B88M, Type K, annealed.
 - .1 Fittings: ASME B16.26, cast bronze.
 - .2 Joints: Flared.
- .3 Steel Pipe: ASTM A53 or ASME B36.10, Schedule 40 black.
 - .1 Fittings: ASTM B16.3, malleable iron, or ASTM A234/A234M, wrought carbon steel and alloy steel welding type.
 - .2 Joints: NFPA 30, threaded or welded to ANSI B31.1.

2.3 PIPE HANGERS AND SUPPORTS

- .1 Conform to NFPA 31.
- .2 Hangers for Pipe Sizes 1" - 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
- .3 Hangers for Pipe Sizes 2" (50 mm) 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 3-1/4" (80 mm): Cast iron hook.
- .6 Vertical Support: Steel riser clamp.
- .7 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .8 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.4 FLANGES, UNIONS, AND COUPLINGS

- .1 Pipe Size 2" (50 mm) and Under:
 - .1 Ferrous pipe: 1034 kPa malleable iron threaded unions.
 - .2 Copper tube: 1034 kPa bronze unions with brazed joints.
- .2 Pipe Size Over 2" (50 mm):
 - .1 Ferrous pipe: 1034 kPa forged steel slip-on flanges; 1/16" (1.6 mm) thick preformed neoprene gaskets.
 - .2 Copper tube: 1034 kPa slip-on bronze flanges; 1/16" (1.6 mm) thick preformed neoprene gaskets.

2.5 VALVES - GENERAL

- .1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
- .2 Provide valves of the same manufacturer where possible.
- .3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
- .4 Valid CRN (Canadian Registration Number) required for each valve.
- .5 Materials:
 - .1 Bronze: ASTM B62 or B61 as applicable
 - .2 Brass: ASTM B283 C3770
 - .3 Cast Iron: ASTM A126 Class B
- .6 End Connections:
 - .1 Threaded ends: ANSI B1.20.1
 - .2 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
 - .3 Face-to-face dimensions: ANSI B16.10
- .7 Design and Testing:
 - .1 Ball Valves: MSS-SP-110
 - .2 Cast Iron Check: MSS-SP-71
- .8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products include:
 - .1 Kitz
 - .2 Crane, Jenkins
 - .3 Conbraco.
 - .4 Nibco

2.6 NATURAL GAS PRV

- .1 Provide NG regulators, one for the building line and another for the Generator.
- .2 Building NG line regulator from 5 PSI to 1.75KPA (7" W.C.)
- .3 Generator NG line regulator from 5 PSI to 3.5 KPA (14" W.C.)
- .4 PRV's by Watts or equal product by other manufacturers.

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.
- .4 Excavate for work of this Section.
- .5 Backfill for work of this Section.

3.3 INSTALLATION

- .1 Install to code.
- .2 Provide non-conducting dielectric connections wherever jointing dissimilar metals. Install to NACE RP-01-69.
- .3 Route piping in orderly manner 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 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .7 Provide clearance for installation of insulation and access to valves and fittings.
- .8 Provide flexible pipe connections at the generator.
- .9 Establish elevations of buried piping outside the building to ensure not less than 1m of cover.
- .10 Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
- .11 Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.
- .12 Identify piping systems including underground piping.
- .13 Install valves with stems upright or horizontal, not inverted.
- .14 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- .15 Paint all finished natural gas piping with yellow paint and identify piping with proper markings.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to:
 - .1 The Contract **CCDC 2-2008**, Stipulated Price Contract as amended,
 - .2 Division 1 requirements and documents referred to therein.
- .2 Section 23 01 01 applies to and governs the work of all Sections of Mechanical Division.
- .3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..
- .4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.
- .5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

1.2 DEFINITIONS

- .1 The following are definitions of words found in this specification and on associated drawings under this Division:
 - .1 "Concealed" - locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
 - .2 "Exposed" - mechanical work normally visible to building occupants.
 - .3 "Furnish" - (and its derivatives) has the same meaning as the term "Supply".
 - .4 "Install" - (and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
 - .5 "Provide" - (and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
 - .6 "Supply" - (and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
 - .7 "Wet" - locations exposed to moisture, requiring special materials and arrangement.

1.3 WORK INCLUDED

- .1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
- .2 Cutting and patching of new or existing work
- .3 Excavating and backfilling
- .4 Identification of equipment, piping, ductwork, and valves and controllers
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches.
- .6 Motors required for equipment supplied under this Division.
- .7 Variable frequency drives for motors and equipment supplied under this Division.
- .8 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.

- .9 Disconnect switches for exhaust fans located on the roof complete with;
 - .1 EEMAC 1 enclosure if housed within a weatherproof cabinet,
 - .2 EEMAC 3 enclosure if exposed to weather
- .10 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and construction of the new addition. Coordinate this protective work with all trades.
- .11 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.
- .12 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.4 RELATED WORK

- .1 Power wiring, conduit and connections for motors under this Division will be by Division 26.
- .2 Power wiring, conduit and connections to variable frequency drives for motors under this Division will be by Division 26. Wiring and connections from VFD to motors under this Division will be by Division 26.
- .3 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.
- .4 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches will be provided under Division 3.

1.5 SUBMITTALS

- .1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.
- .2 Shop Drawings: Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.
 - .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
 - .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
 - .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.
 - .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:
"This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."
- .3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate

the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Mechanical Division. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.

- .4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.
- .5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:
 - .1 description of the system (description and type),
 - .2 description of the tests conducted and results observed, including re-testing, where necessary,
 - .3 description of any corrective measures undertaken,
 - .4 description of materials used (pipe and fittings),
 - .5 list of witnesses for each test conducted,
 - .6 date system left ready for service,
 - .7 signature of installing Contractor.
- .6 Directories & Schematics
 - .1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service, and location of each valve under this Division.
 - .2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.
 - .3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.
- .7 Maintenance Data and Operating Instructions
 - .1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.
 - .2 Ensure the binder spines have typewritten lettering as follows:
OPERATION & MAINTENANCE MANUAL
for
[Insert name of project]
[Insert date of submission]
[Insert Division Title]
 - .3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.
 - .4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.
 - .5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.
 - .6 Ensure operating instructions include the following:
 - .1 General description of each mechanical system.
 - .2 Step by step procedure to follow in putting each piece of equipment into service.
 - .3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
 - .4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.

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- .5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.
 - .7 Ensure maintenance instructions include the following:
 - .1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.
 - .2 Summary list of each item of mechanical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.
 - .3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.
 - .4 Balancing and testing reports.
 - .5 Copy of valve directory.
 - .8 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to paragraph 3.2.5 and to Division 1 for requirements.
 - .9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.
 - .10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

1.6 QUALITY ASSURANCE

- .1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.
- .2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:

.1	AABC	Associated Air Balance Council
.2	AMCA	Air Moving and Conditioning Association
.3	ANSI	American National Standards Institute
.4	ASA	American Standards Association
.5	ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
.6	ASME	American Society of Mechanical Engineers
.7	ASSE	American Society of Sanitary Engineers
.8	ASPE	American Society of Plumbing Engineers
.9	ASTM	American Society of Testing and Materials
.10	AWWA	American Water Works Association
.11	CAN2	National Standard of Canada (Published by CGSB)
.12	CAN3	National Standard of Canada (Published by CSA)
.13	CGSB	Canadian General Standards Board
.14	CSA	Canadian Standards Association
.15	EEMAC	Electrical & Electronic Manufacturer's Association of Canada
.16	NBC	National Building Code of Canada
.17	NEBB	National Environmental Balancing Bureau
.18	NFPA	National Fire Protection Association
.19	NEMA	National Electrical Manufacturers Association
.20	OBC	Ontario Building Code
.21	OFC	Ontario Fire Code
.22	OFM	Ontario Fire Marshall
.23	SMACNA	Sheet Metal & Air Conditioning Contractors National Association
.24	TIAC	Thermal Insulation Association of Canada
.25	ULC	Underwriter's Laboratories of Canada Ltd
.26	UL	Underwriter's Laboratories (including cUL)

- .3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.
- .4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.
- .5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.
- .6 All welding and brazing shall be executed by certified welders in accordance with registered procedures.
- .7 All refrigeration work shall be executed only by mechanics with valid ODP cards.

1.7 PRODUCT DELIVERY, HANDLING AND STORAGE

- .1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.
- .2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.8 JOB CONDITIONS

- .1 Visit site and examine existing conditions which may affect work of this Division.
- .2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
- .4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without

qualifications, unless exceptions are specifically noted in the Bid.

1.9 INTERRUPTIONS

- .1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
- .2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
- .4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
- .5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.10 WARRANTY

- .1 Refer to Division 1 and to Section 23 01 01 General Requirements.
- .2 Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.
- .3 Make submissions necessary to register product warranties to the benefit of the Owner.
- .4 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

1.11 EXTRAS AND CREDITS

- .1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
 - .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
 - .2 Labour hours and unit costs.
 - .3 Total materials and labour costs.
 - .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.
- .2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.
- .3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.
- .4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 MOTOR STARTERS & CONTROLS

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- .1 Mechanical Division shall provide all motor starters and associated controls required and as scheduled on drawings and noted for Mechanical Division equipment. Starters and controls shall be Canadian General Electric or Alternate noted. All starters, contactors, thermal overloads, etc. must be EEMAC rated. All starters shall be of one manufacturer except as specifically approved otherwise for integral pre-wired assemblies.
 - .2 Starter and control units shall be equipped with necessary number of auxiliary contacts and relays to provide control sequences described in Mechanical Equipment Starter Schedule on Drawings. Auxiliary contacts shall be interchangeable normally open or normally closed, by conversion in field without additional parts exterior to starter.
 - .3 Manual starters may only be provided for single phase equipment operated by control device such as thermostat or limit control when such control device is rated for full electrical load of equipment.
 - .4 Manual starters provided for single phase equipment actuated by electric timer or shall have H.O.A. feature. "Hand" position shall permit shunting of time switch. Where such units also have protective device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" positions and shall not be shunted.
 - .5 Manual starters may only be provided for three phase equipment which is not actuated by pilot control device (pressure switch, float switch, safety limit devices, remote manual control device) unless otherwise noted in Starter Schedule.
 - .6 Magnetic starters for manually operated equipment shall have "On/Off" selector switch or "Start-Stop" pushbutton in cover as scheduled.
 - .7 Magnetic starters which are started automatically by electric time switch shall include "Hand-Off-Automatic" (H.O.A.) selector switch. "Hand" position shall permit shunting of time switch or E.M.S. Where such units also have protective pilot device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" position and shall not be shunted.
 - .8 Magnetic starters which are started automatically by remote pilot device (or interlocked units) such as level controller, pressure switch, thermostat or flow switch shall include "Hand-off-Auto" (H.O.A.) selector switch, and, where scheduled, a "Test" pushbutton. "Hand" position shall permit shunting of remote pilot device and thereby permit operation of starter but only while depressing "Test" button.
 - .9 Equip starter apparatus for prime plumbing, heating, air conditioning and ventilating equipment so that these units will automatically restart on resumption of power after power outage. Starters for these units shall have "On/Off" selector switch in cover if not fitted with H.O.A. selector feature or manual starter or otherwise noted.
 - .10 Safety control device such as flow switches, pressure switches, high and low limited ("Fire" and "Freeze") shall not be shunted by "Hand" position of switch.
 - .11 Manual motor starter shall be toggle operated with following general construction features:
 - Quick-Make, Quick-Break mechanism with double-break contacts.
 - Overload protection heaters, one per phase and speed.
 - Enclosure to suit application.
 - Pilot light, neon lamp.
 - Cover engraved with "On-Trip-Off".
 - .12 Magnetic motor starters shall comprise electrically-operated motor starters combined with disconnect switch with following general construction features:
 - Quick-Make, Quick-Break mechanism with double-break contacts.
 - Fuse holders to accept specified fuses, one per phase.
 - Adjustable overload relays, one per phase.
 - CEMA listed enclosure to suit application. Disconnect with mechanical cover interlocks, line side barriers and switch operated electrical interlocks to disconnect external control voltage unless starter includes suitable approved enclosed contacts and connections.
 - "Reset" button.
 - Pilot Lights of transformer type incandescent with amber safety lens cap.
 - Control transformer with 120 volt fused secondary and sized to suit current rating of associated control devices.

- Scheduled cover mounted control devices with standard duty double break contact blocks.
- Minimum of two auxiliary contacts (unused "Seal-in" contact may be included).
- .13 Contactors for non-motor applications shall be built similar to combination magnetic starters, except less overload relays, and with Gould Shawmut AJT time delay HRC1-J fuses, rated for load, and with enclosed continuous current rating of at least 125% of connected full load.
- .14 "Double Voltage Relays" shall be CGE Model CR120 LXMC with general purpose enclosure, number of contacts required and "Mylar" shroud of enclosure of contacts, or approved equivalent.
- .15 Pilot devices such as "Start-Stop" pushbuttons, "Hand-Off-Auto" selector switches and indicating lights shall be of heavy-duty construction. Indicating lamps shall be transformer type incandescent with amber safety lens caps.
- .16 Each control unit shall be provided with engraved nameplates for designation of device controlled and duty. See Subsection "Equipment Markers & Nameplates" for details.
- .17 Control wiring shall be 120 volt A.C. maximum. Provide control circuit transformers where these are not included in motor starters. Secondaries of control transformers shall be fused with one side grounded and controls, safety devices and interlocks shall be connected in ungrounded conductor, excepting only integral starter overload devices.
- .18 Single phase motors interlocked to start or operate with other equipment shall be provided with magnetic starters or suitable relays with necessary auxiliary contacts and double voltage relays or be otherwise electrically separated.
- .19 Overload relay heaters for starters shall be selected and field adjusted to trip at maximum value of 115% of actual nameplate full load amperes. Selection of heater elements shall be based on starter manufacturer's recommendations. Obtain data from Mechanical Division. Submit Motor Starter Schedule which shall list following for each motor:
 - Proposed equipment nameplate data
 - Actual full load amperes of motor
 - Speed of motor
 - Temperature Class in degrees Celsius rise and insulation class.
 - Circuit breaker or fuse type and proposed rating
 - Type of motor, duty and service factor.
- .20 Overload relay heaters shall trip in 20 seconds or less from cold or motor-locked rotar condition.
- .21 Where equipment is noted to be electrically interlocked, provide necessary interlocks, double voltage relays (Mylar shroud accepted) to provide specified operation.
- .22 Provide all fuses required to protect equipment. Fuses shall be proper size blade type time delay HRC1-J current limiting. Supply three spare fuses of each size and type and obtain duplicate receipt for same. Fuse clips shall reject standard NEC fuses. Fuses shall be rated in accordance with manufacturer's published data. Fuses to be of one manufacturer throughout.
- .23 Acceptable Alternate Manufacturers
 1. Furnas Electric
 2. Westinghouse
 3. Allen Bradley
 4. Square 'D'
 5. Cutler Hammer
 6. Klockner-Moeller.
 7. Commander
 8. Telemecanique

2.3 EQUIVALENTS AND ALTERNATIVES

- .1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

- .2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.
- .3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to indicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

- .1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.
- .2 Apply, in writing, to consultant for substitution of any products, indicating the following:
 - .1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
 - .2 Reason for substitution.
 - .3 Any revisions to the contract price made necessary by substitution.
 - .4 Any revisions to the contract time made necessary by substitution.
 - .5 Any revisions to layout, arrangement or services made necessary by substitution.
- .3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

- .1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.
- .2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

3 Execution

3.21 INSTALLATION REQUIREMENTS

- .1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
- .2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
- .3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
- .4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
- .5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
- .6 Provide suitable shielding and physical protection for devices.
- .7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
- .8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose

- undue stresses on the structure and systems.
- .9 Do not use powder activated tools except as permitted by the Prime Consultant and the Owner's workplace health and safety policies.
- .10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.2 CONTRACT DRAWINGS

- .1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
- .2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.
- .3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.
- .4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.
- .5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.
- .6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.
- .7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

3.3 CONSTRUCTION DRAWINGS

- .1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.
- .2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.
- .3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.
- .4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.
- .5 Submit construction drawings prior to commencement of work.

3.4 RECORD DRAWINGS

- .1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".
- .2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.
- .3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.
- .4 Record location of concealed services, particularly underground services. Before commencing any

backfilling, obtain accurate measurements and information concerning correct location and depth of services.

- .5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.
- .6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

3.5 USE OF EQUIPMENT

- .1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.
- .2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the edges are sealed so that the filters are not bypassed. Change the filters frequently, to the satisfaction of the Consultant, until the building is turned over to the Owner.

3.6 SPECIAL TOOLS AND SPARE PARTS

- .1 Within 30 days of award of contract, prepare a complete itemized list of special tools and spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.
- .2 On completion of the project furnish spare parts to the Owner as follows:
 - .1 One set of mechanical seals for each pump.
 - .2 One casing joint gasket for each pump.
 - .3 One head gasket for each heat exchanger.
 - .4 One glass for each gauge glass installed.
 - .5 One set of v-belts for each piece of machinery.
 - .6 One set of new filters for each filter bank installed.
- .3 Identify spare parts containers as to contents and replacement parts number.
- .4 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

3.7 INSTRUCTION

- .1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instruction for each system separately.
- .2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
- .3 Ensure each instruction period includes, but is not limited to the following;
 - .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
 - .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
 - .3 demonstration of the proper operating procedures for each item of equipment,
 - .4 explanation of the purpose and function of all safety devices provided,
 - .5 demonstration of all measures required for safe and proper access for operation and maintenance.
- .4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.
- .5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

3.8 START UP AND COMMISSIONING

- .1 The Contractor shall start up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
- .2 The Startup and Commissioning Team shall be comprised of;
 - .1 The individual, company or agency undertaking the work of each Section,
 - .2 Representatives of the Contractor and his sub-contractors as required,
 - .3 Representatives of equipment manufacturers,
 - .4 Representatives of the Consultants,
 - .5 Representatives of the Owner.
- .4 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the startup and commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.
- .5 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.
- .6 Each Section shall prepare Check Sheets in accordance with the standards listed above and shall issue them to the commissioning team for use during the commissioning process.
- .7 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;
 - .1 name and logo of Facility,
 - .2 name of the project,
 - .3 the Owner's project number,
 - .4 identification of the system commissioned,
 - .5 the date that the system was commissioned.
- .8 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

End of Section

PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 1.

1.2 APPLICABLE STANDARDS

- .1 Applicable Standards are listed below:
 - .1 ASHRAE Standard 202-2024 - The Commissioning Process Requirements for New Buildings and New Systems
 - .2 ASHRAE Standard 230-2022 - Commissioning Process for Existing Buildings and Systems
 - .3 ASHRAE Guideline 0-2019 - the Commissioning Process
 - .4 ASHRAE Guideline 0.2-2015 - Commissioning Process for Existing Systems and Assemblies
 - .5 ASHRAE Guideline 1.1-2025 - Application of the Commissioning Process to New HVAC&R Systems
 - .6 ATSM E2813 – Standard Practice for Building Enclosure Commissioning
 - .7 ATSM E2947 – Standard Guide for Building Enclosure Commissioning
 - .8 CaGBC LEED v4.1 Building Design and Construction Reference Guide
 - .1 LEED EA p1: Fundamental Commissioning and Verification
 - .2 LEED EA c1: Option 1. Path 1: Enhanced Commissioning
 - .9 CSA Z320-11 Building Commissioning Standard & Check Sheets
 - .10 CSA C282-15 – Emergency Power Supply for Buildings
 - .11 NIBS Guideline 3-2012 – Building Enclosure Commissioning Process

1.3 GENERAL

- .1 The purpose of this section is to specify Division 23 responsibilities in the commissioning process.
- .2 Commissioning requires the participation of Division 23 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 23 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.4 SYSTEMS TO BE COMMISSIONED

- .1 Systems to be commissioned as part of this contract include, but may not be limited to the following:
 - .1 Mechanical, including HVAC & R equipment and controls
 - .2 Applicable meters

1.5 COMMISSIONING TEAM

- .1 The Commissioning Team shall consist of representatives of the following as appropriate:

- .1 Owner and the Owner's FM Staff
- .2 Consultant
- .3 Commissioning Authority (CxA)
- .4 General Contractor (GC)
- .5 Subcontractors (Mechanical, Electrical, Controls, TAB)
- .6 Specialized third-party for verification

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 COMMISSIONING AUTHORITY RESPONSIBILITIES

- .1 The Commissioning Authority shall:
 - .1 Plan, organize and implement the commissioning process as specified herein;
 - .2 Prepare the commissioning plan, ensure its distribution for review and comment;
 - .3 Revise the commissioning plan as required during construction;
 - .4 Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
 - .5 In conjunction with the GC, coordinate commissioning activities;
 - .6 Monitor system verification checks, and ensure the results are documented as the checks are done;
 - .7 Observe select start-ups and initial system operations tests and checks;
 - .8 Develop Functional Test scripts
 - .9 Direct the GC to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
 - .10 Witness functional performance tests and document the results;
 - .11 Prepare and submit a commissioning report which documents all checks and tests done throughout the commissioning process, and the results obtained from each;
 - .12 Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated facility operating staff.

3.2 CONSULTANT RESPONSIBILITIES

- .1 The Consultant commissioning responsibilities are outlined below:
 - .1 Review the commissioning plan, proposed test procedures, and participate (as appropriate) in on-site commissioning meetings.
 - .2 At their discretion during the acceptance phase of the commissioning process, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance

3.3 OWNER/ PROJECT MANAGER RESPONSIBILITIES

- .1 The Owner shall have the following commissioning responsibilities
 - .1 Ensure the availability of facility operations staff for all scheduled instructions and demonstration sessions (training).
 - .2 At their discretion, witness commissioning performance tests.

3.4 SUBCONTRACTOR RESPONSIBILITIES

- .1 The Contractor shall ensure that the Subcontractor complies with all requirements included in this Section and fulfills the following responsibilities during construction and acceptance phases in addition to those listed above are (all references apply to commissioned equipment only)
 - .1 Documentation of all procedures performed shall be provided and forwarded to the Consultant. Written documentation must contain recorded test values of all tests performed per the individual product specification.
 - .2 The start-up service company shall be present during energization of the mechanical equipment. Jobsite and equipment access must be provided by the Subcontractor.
 - .3 The Contractor shall supply a power source, specified by the start-up service company, for on-site test equipment.
 - .4 The subcontractor is to attend all factory witness testing required within the respective specification sections. All costs associated with the HVAC system commissioning specified in this Section shall be included in the bid price.
 - .5 Perform tests using qualified personnel. Provide necessary instruments and equipment.
 - .6 Include the cost of commissioning in the contract price, if not yet included.
 - .7 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
 - .8 Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
 - .9 Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of pre-functional and functional testing procedures.
 - .1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation 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 Commissioning Authority.
 - .2 The Commissioning Authority may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
 - .10 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CxA for review.

- .11 Contractors shall assist (along with the Consultant) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- .12 Provide assistance to the CxA in preparation of the specific functional performance test procedures specified in Division 23. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- .13 Develop a full start-up and checkout plan using manufacturer's start-up procedures and the pre-functional test sheets from the CxA. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CxA for review.
- .14 During the startup and checkout process, execute and document the mechanical-related portions of the pre-functional test sheets provided by the CxA for all commissioned equipment.
- .15 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
- .16 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. 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.
- .17 Perform functional performance testing under the direction of the CxA for specified equipment to be commissioned. Assist the CxA in interpreting the monitoring data, as necessary.
- .18 Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC and Consultant and retest the equipment.
- .19 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- .20 During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for subcontractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for subcontractor-generated coordination drawings.
- .21 Provide training of the Owner's operating personnel as specified.
- .22 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- .23 Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
- .24 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- .2 Assist and cooperate TAB subcontractor and CxA by:
 - .1 Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
 - .2 Including cost of sheaves and belts that may be required by TAB.
 - .3 Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.

- .4 Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
- .3 Install a P/T plug at each water sensor which is an input point to the control system.
- .4 List and clearly identify on the as-built drawings the locations of applicable sensors and meters
- .5 Prepare a preliminary schedule for Division 23 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.
- .6 Notify the Consultant, Owner/PM, GC or CxA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the Consultant, GC or CxA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CxA has the scheduling information needed to efficiently execute the commissioning process.

3.5 TESTING, ADJUSTING, AND BALANCING (TAB) SUBCONTRACTOR RESPONSIBILITIES

- .1 The GC shall ensure that the TAB subcontractor complies with the following duties:
 - .1 Six weeks prior to starting TAB, submit to the PM/GC the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The Owner will approve the site technician's qualifications for this project.
 - .2 Submit the outline of the TAB plan and approach for each system and component to the Consultant, Owner/PM, CxA, GC and the Controls Subcontractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system. The submitted plan will include:
 - .1 Certification that the TAB subcontractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
 - .2 An explanation of the intended use of the building control system. The Controls Subcontractor will comment on feasibility of the plan.
 - .3 All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - .4 Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - .5 Final test report forms to be used.
 - .6 Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow strengtheners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.
 - .7 List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - .8 Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply air (SA) and return air (RA) pilot

- traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
- .9 The identification and types of measurement instruments to be used and their most recent calibration date.
 - .10 Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
 - .11 Confirmation that TAB understands the outside air ventilation criteria under all conditions.
 - .12 Details of whether and how minimum outside air cfm will be verified and set and for what level (total building, zone, etc.).
 - .13 Details of how building static and exhaust fan / relief damper capacity will be checked.
 - .14 Proposed selection points for sound measurements and sound measurement methods.
 - .15 Details of methods for making any specified coil or other system plant capacity measurements.
 - .16 Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
 - .17 Details regarding specified deferred or seasonal TAB work.
 - .18 Details of any specified false loading of systems to complete TAB work.
 - .19 Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - .20 Details of any required interstitial cavity differential pressure measurements and calculations.
 - .21 Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - .22 Plan for formal progress reports (scope and frequency).
 - .23 Plan for formal deficiency reports (scope, frequency and distribution).
- .2 A running log of events and issues shall be kept by the TAB field technicians. The TAB subcontractor shall submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA, Owner/PM, Consultant and GC at least twice a week.
 - .3 Communicate in writing to the Controls Subcontractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
 - .4 Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB.
 - .5 Provide the CxA with any requested data, gathered, but not shown on the draft reports.
 - .6 Provide a final TAB report for the Consultant, Owner, CxA with details, as in the draft.

- .7 Conduct functional performance tests and checks on the original TAB as specified for TAB in Section 23 08 00

3.6 SUBMITTALS

- .1 Section 23 Contractors shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 01 91 00 for additional Division 23 requirements.

3.7 START-UP OF EQUIPMENT

- .1 The GC shall ensure that the HVAC contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 00, part 3.10. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA or Owner.
- .2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA, Consultant and GC. Beginning system testing before full completion does not relieve the Subcontractor from fully completing the system, including all pre functional checklists as soon as possible.
- .3 Prior to the startup of equipment, the Division 23 Subcontractor shall arrange to have the Manufacturer of all major equipment inspect the installation to ensure their equipment has been installed in accordance with their recommendations.
- .4 The Supplier shall submit a written report of their findings.
- .5 Upon confirmation that the equipment has been installed in accordance with the Manufacturers Recommendations the equipment may be started.
- .6 All equipment shall be started by the Manufacturer's representative.

3.8 PRE-FUNCTIONAL TEST SHEETS

- .1 Pre-functional test sheets contain items for Division 23 Contractors to perform. On each checklist, a column is provided that is to be completed by the contractor assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.
- .2 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout. Items that do not apply should be noted along with the reasons on the form. If this form is not used for documenting, one of similar rigor and clarity shall be used pending approval from the CxA.

3.9 FUNCTIONAL TESTING, DOCUMENTATION, NON-CONFORMANCE AND ACCEPTANCE

- .1 Refer to Specification 01 91 00 for more information in addition to this 23 08 00.

3.10 OPERATION AND MAINTENANCE MANUALS

- .1 Division 23 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 23 and deliver to the GC for inclusion in the O&M manuals.
- .2 ASHRAE Guideline 4-2008 is the recommended format.
- .3 The CxA shall receive a copy of the O&M manuals for review.

3.11 TRAINING OF OWNER PERSONNEL

- .1 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 00 for additional details.
- .2 The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 00 for additional details.
- .3 The Mechanical Subcontractor shall have the following training responsibilities:
 - .1 Provide the CxA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.14.
 - .2 Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.
 - .3 Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, 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 person may be the start-up technician for the piece of equipment, the installing subcontractor 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 is required. More than one party may be required to execute the training.
 - .6 The controls subcontractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
 - .7 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 - .8 Training shall include:
 - .1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - .2 A 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, shut-down, 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 Explanatory 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.
- .4 The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1, latest edition is recommended.
 - .5 Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
 - .6 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
 - .7 The mechanical subcontractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
 - .8 Training shall occur after functional testing is complete, unless approved otherwise by the Consultant and/or Owner/Project Manager.

3.12 DEFERRED TESTING

- .1 Refer to Section 01 91 00, Part 3.15 for requirements of deferred testing.

3.13 WRITTEN WORK PRODUCTS

- .1 Written work products of Section 23 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets. Refer to Section 01 91 00 Part 3.16.

END OF SECTION

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 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.

1.3 REFERENCES

- .1 ASME B31.1 - Power Piping.
- .2 ASME B31.2 - Fuel Gas Piping.
- .3 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
- .4 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- .5 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- .6 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- .7 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- .8 NFPA 13 - Installation of Sprinkler Systems.
- .9 NFPA 14 - Installation of Standpipe, Private Hydrants, and Hose Systems.
- .10 UL 203 - Pipe Hanger Equipment for Fire protection Service.

1.4 SUBMITTALS

- .1 Section 23 01 01: Procedures for submittals.
- .2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- .3 Product Data: Provide manufacturers catalogue data including load capacity.
- .4 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- .5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

- .1 Conform to CSA B-51 for support of piping.

2 Products

2.1 PIPE HANGERS AND SUPPORTS

- .1 Manufacturers:
 - .1 Anvil
 - .2 Myat
 - .3 Hunt
- .2 Plumbing Piping:
 - .1 Conform to CSA B-51 and ASME B31.1
 - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
 - .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
 - .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
 - .5 Hangers for Hot Pipe Sizes 6" (150 mm) 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 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
- .8 Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.

-
- .9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
 - .10 Wall Support for Hot Pipe Sizes 6" (150 mm) 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 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - .14 Floor Support for Hot Pipe Sizes 6" (150 mm) 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.
 - .3 Refrigerant Piping:
 - .1 Conform to ASME B31.5.
 - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
 - .3 Hangers for Pipe Sizes 2" (50 mm) 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 3" (75 mm): Cast iron hook.
 - .6 Wall Support for Pipe Sizes 4" (100 mm) 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.

2.2 ACCESSORIES

- .1 Hanger Rods: galvanized, carbon steel continuous threaded.
- .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.

2.3 EQUIPMENT ROOF CURBS

- .1 Fabrication: Welded 0.05" (1.2 mm) galvanized steel shell and base, mitred 3" (75 mm) cant, variable step to match roof insulation, factory installed wood nailer.

2.4 ROOFTOP PIPE/DUCT SUPPORTS

- .1 Acceptable manufacturers;
 - .1 Portable Pipe Hangers, Inc.
 - .2 Unistrut
- .2 Pre-engineered pipe/duct support system including;
 - 1. Bases: weather resistant and UV radiation resistant with seismic attachments
 - 2. Framing: 1-5/8" (41.3mm) strut or 1-7/8" (47.6mm) strut, fabricated of steel to ASTM A570, Grade 33., roll formed of 12-gauge (2.7mm thick) steel into 3-sided or tubular shape.
 - 3. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69, fabricated of carbon steel. Single roller supports for piping subject to expansion and contraction.
 - 4. Finishes:
 - .1 Plastics as moulded with UV radiation protection.
 - .2 Metal surfaces hot dip galvanized free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets and other surface blemishes. Galvanizing shall conform to ASTM A123 for tubing and to ASTM A153 for hardware and accessories.
 - .5 Shop Drawings: Manufacturer to provide detailed shop drawings to indicate layout and supporting capacities of system components with installation and assembly instructions for each application. Shop drawings shall bear the signature and seal of a professional engineer licenced in Ontario.

3 Execution

3.1 INSTALLATION

- .1 Install to manufacturer's instructions and best trade practices.

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 4" (100 mm).
- .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 slab.

3.3 PIPE HANGERS AND SUPPORTS

- .1 Support horizontal piping in accordance with code requirements. Where there are no code requirements support as scheduled below.
- .2 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
- .3 Place hangers within 12" (300 mm) of each horizontal elbow.
- .4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.
- .5 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) 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.
- .10 Design hangers for pipe movement without disengagement of supported pipe.
- .11 Prime coat exposed steel hangers and supports. Refer to Section 09 91 10. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 EQUIPMENT BASES AND SUPPORTS

- .1 Provide housekeeping pads of concrete, minimum 4" (100 mm) thick and extending 6" (150 mm) 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 ROOFTOP PIPE/DUCT SUPPORT

- .1 Coordinate installation of supports and bases with roofing work. Ensure that roofing surfaces are smooth and flat and are ready to receive work.
- .2 Use care in installation of support systems not to damage roofing, flashing, equipment or related materials.
- .3 Install and secure support systems in strict accordance with manufacturer's written instruction.
- .4 Consult manufacturers of roofing system to determine if walk pads are required. Provide and fully adhere walk pads to roof system where required.
- .5 Bases and support framing shall be located as indicated on shop drawings provided by support system manufacturer and as specified herein. The support of all piping shall be complete and adequate, whether or not all required devices are shown.
- .6 The use of wood or wire for supporting piping will not be permitted.
- .7 Deflection of pipes shall not exceed 1/240th of the span.
- .8 Accurately locate and align bases. Where applicable, replace gravel around bases. Set framing posts

- into bases and assemble framing structure as indicated.
- .9 Use galvanized fasteners for galvanized framing, and use stainless steel fasteners for stainless steel framing.

3.6 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 3" (75 mm) minimum above finished roof surface with lead worked 1" (25 mm) minimum into hub, 8" (200 mm) minimum clear on sides with 24" x 24" (600 x 600 mm) 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, 10" (250 mm) clear on sides with minimum 36" x 36" (910 x 910 mm) sheet size. Fasten flashing to drain clamp device.
- .4 Seal roof, floor, shower and mop sink drains watertight to adjacent materials.
- .5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's instructions for sound control.
- .6 Provide curbs for mechanical roof installations 14" (350 mm) 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.

3.7 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 1" (25 mm) 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 stuffing 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.

3.8 SCHEDULES

- .1 Imperial Measure (IP)

Pipe Size(in)	Rod Diameter (in)	Support Spacing (Ft)	
		Steel Pipe	Copper Tube
1/2	3/8	7	6
3/4	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9
2-1/2	3/8	12	10
3	3/8	12	10
4	5/8	14	12
6	7/8	17	
8	7/8	19	
10	7/8	21	
12	7/8	23	
14	1	25	
16	1	27	
18	1	28	

.2 Metric Measure (SI)

Pipe Size(mm)	Rod Diameter (mm)	Support Spacing (m)	
		Steel Pipe Tube	Copper
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4
50	10	3	2.7
65	10	3.6	3
75	10	3.6	3
100	16	4.2	3.6
150	22	17	
200	22	5.7	
250	22	6.4	
300	22	7	

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Vibration control of piping, ductwork and equipment.
.2 Inertia bases.

1.3 REFERENCES

- .1 Ontario Building Code.
.2 SMACNA "HVAC Duct Construction Standards"

1.4 PERFORMANCE REQUIREMENTS

- .1 Provide vibration isolation on motor driven equipment over 0.35 kW, plus connected piping and ductwork.
.2 Provide minimum static deflection of isolators for equipment as indicated.
.1 Upper Floors, Normal
.1 Under 400 rpm: 1-1/2" (40 mm)
.2 400 - 600 rpm: 3-1/2" (90 mm)
.3 600 - 800 rpm: 2" (50 mm)
.4 800 - 900 rpm: 1" (25 mm)
.5 1100 - 1500 rpm: 1/2" (12 mm)
.6 Over 1500 rpm: 1/4" (5 mm)
.3 Use concrete inertia bases for fans having static pressure in excess of 3.4 IN. WG (0.85 kPa) or motors in excess of 40 HP (30 kW), and on base mounted pumps over 10 HP (7.5 kW).
.4 Provide seismic restraints in accordance with Ontario Building Code requirements for Post Disaster Buildings. Seismic restraints shall be designed, installed and reviewed under the direct supervision of a professional engineer licensed in the Province of Ontario.

1.5 SUBMITTALS

- .1 Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.
.2 Product Data: Provide schedule of vibration isolator type with location and load on each.
.3 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
.4 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.6 PROJECT RECORD DOCUMENTS

- .1 Record actual locations of hangers including attachment points.

1.7 Copy of REFERENCES

- .1 AGA Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.
.2 ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
.3 ASME B16.3 - Malleable Iron Threaded Fittings.
.4 ASME B16.4 - Grey Iron Threaded Fittings.
.5 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
.6 ASME B16.22-2001 (R2005) - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
.7 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
.8 ASME B16.26 - Copper Alloy Bronze Fittings for Flared Copper Tubes.

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- .9 ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
 - .10 ASME B16.32 - Cast Copper Alloy Solder Joint Fittings for Sovent Drainage Systems.
 - .11 ASME B31.1 - Power Piping.
 - .12 ASME B31.2 - Fuel Gas Piping.
 - .13 ASME B31.9 - Building Services Piping.
 - .14 ASTM A47/A47M - Ferritic Malleable Iron Castings.
 - .15 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - .16 ASTM A74 - Cast Iron Soil Pipe and Fittings.

1.8 SUBMITTALS FOR REVIEW

- .1 Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.9 QUALITY ASSURANCE

- .1 Products of This Section: Manufactured to ISO 9000 certification requirements.
- .2 Perform Work to Province of Ontario, standards. Maintain one copy on site.
- .3 Valves: Manufacturer's name and pressure rating marked on valve body.
- .4 Welding Materials and Procedures: Conform to ASME SEC IX and applicable provincial labour regulations.
- .5 Welder's Certification: To ASME SEC IX.
- .6 Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.10 REGULATORY REQUIREMENTS

- .1 Perform Work to applicable Province of Ontario 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.

2 Products

2.1 MANUFACTURERS

- .1 Manufacturer shall be a member of VISCMA.
- .2 Coordinate selection of Manufacturer with Section 15191.
- .3 Acceptable manufacturers;
 - .1 Vibron/Kinetics.
 - .2 VAW Systems.
 - .3 Korfund
 - .4 Masdom

2.2 INERTIA BASES

- .1 Structural Bases:
 - .1 Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
 - .2 Construction: Welded structural steel with gusseted brackets, supporting equipment and motor with motor slide rails.
- .2 Concrete Inertia Bases:
 - .1 Mass: Minimum of 1.5 times weight of isolated equipment.
 - .2 Construction: Structured steel channel perimeter frame, with gusseted brackets and anchor bolts, adequately reinforced, concrete filled.
 - .3 Connecting Point: Reinforced to connect isolators and snubbers to base.
 - .4 Concrete: Reinforced 20 mPa concrete.

2.3 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 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - .3 Spring Mounts: Provide with levelling devices, minimum 1/4" (6 mm) thick neoprene sound pads, and zinc chromate plated hardware.
 - .4 Sound Pads: Size for minimum deflection of 0.05" (1.2 mm); 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 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - .3 Spring Mounts: Provide with levelling devices, minimum 1/4" (6 mm) thick neoprene sound pads, and zinc chromate plated hardware.
 - .4 Sound Pads: Size for minimum deflection of 0.05" (1.2 mm); 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 percent 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 1/4" (7 mm) 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 percent 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 1/4" (7 mm) 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 percent 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.
 - .4 Misalignment: Capable of 20 degree hanger rod misalignment.
 - .6 Neoprene Pad Isolators:
 - .1 Rubber or neoprene waffle pads.
 - .1 30 durometer.
 - .2 Minimum 1/2" (13 mm) thick.
 - .3 Maximum loading 275 kPa.
 - .4 Height of ribs: maximum 0.7 times width.
 - .2 Configuration: Single layer.
 - .7 Rubber Mount or Hanger: Moulded rubber designed for 1/2" (13 mm) deflection with threaded insert.
 - .8 Glass Fibre Pads: Neoprene jacketed pre-compressed moulded glass fibre.
 - .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 3/4" (18 mm) thick.
 - .3 Capacity: 4 times load assigned to mount groupings at 3/8" (10 mm) deflection.
 - .4 Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

3 Execution

3.1 INSTALLATION

- .1 Install to manufacturer's instructions.
- .2 Install isolation for motor driven equipment.
- .3 Bases:
 - .1 Set steel bases for 1" (25 mm) clearance between housekeeping pad and base.
 - .2 Set concrete inertia bases for 2" (50 mm) 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 static pressure, and on hanger supported, horizontally mounted axial fans.
- .8 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.06" (1.5 mm) maximum clearance. Provide other snubbers with clearance between 1/8" and 1/4" (4 mm and 7 mm).
- .9 Support piping connections to isolated equipment resiliently as follows:
 - .1 Up to 4" (100 mm) Diameter: First three points of support.
 - .2 5" to 8" (125 to 200 mm) Diameter: First four points of support.
 - .3 10" (250 mm) Diameter and Over: First six points of support.
 - .4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.
- .10 Connect wiring to isolated equipment with flexible hanging loop.

3.2 MANUFACTURER'S FIELD SERVICES

-
- .1 Inspect isolated equipment after installation and submit report. Include static deflections.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 The mechanical contractor will be responsible for the work of Testing, Adjusting and Balancing of HVAC systems as follows;
 - .1 Testing, adjustment, and balancing of air systems.
 - .2 Measurement of final operating condition of HVAC systems.
- .2 This Section shall verify correct operation of;
 - .1 air systems,
 - .2 equipment

1.3 REFERENCES

- .1 Ontario Building Code.
- .2 Ontario Fire Code.
- .3 AABC - National Standards for Total System Balance.
- .4 ACG - AABC Commissioning Guideline.
- .5 ADC - Test Code for Grilles, Registers, and Diffusers.
- .6 ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- .7 ASHRAE Guideline 0 The Commissioning Process,
- .8 ASHRAE Guideline 1 The HVAC Commissioning Process,
- .9 ASHRAE Guideline 1.1 HVAC&R Technical Requirements for the Commissioning Process,
- .10 ASTM E779 Determining Air Leakage Rate by Fan Pressurization.
- .11 NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- .12 SMACNA - HVAC Systems Testing, Adjusting, and Balancing.
- .13 SMACNA HVAC Systems Commissioning Manual,

1.4 SUBMITTALS

- .1 Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
- .2 Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- .3 Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
- .4 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.
- .5 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.
- .6 Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
- .7 Test Reports: Indicate data on AABC National Standards for Total System Balance forms. Submit data in S.I. Metric units.
All reports shall be prepared in electronic (computer) format using MS Word software and all tabulations shall be prepared in electronic (computer) format using MS Excel spreadsheet software. Submittals shall include three (3) copies each of hard copy printout and two (2) copies with text in ".pdf" and tabulations in ".xls" or ".xlsx" formats on CD, DVD, or USB flash drive.

1.5 PROJECT RECORD DOCUMENTS

- .1 Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.
- .2 Record actual locations of flow measuring stations.

1.6 QUALITY ASSURANCE

- .1 Perform total system balance to AABC National Standards for Field Measurement and Instrumentation, Total System Balance.
- .2 Maintain one copy of each document on site.

1.7 INDEPENDENT AGENCY

- .1 All work of Mechanical Testing, Adjusting and Balancing shall be undertaken by a single agency, employed under Mechanical Division.
- .2 The work of the agency consists of the furnishing of all labour, materials, equipment and accessories necessary in the testing, verification and documentation of the operational performance of all equipment and systems installed under the Sections of Mechanical Division.

1.8 QUALIFICATIONS

- .1 Agency: Company specializing in the testing, adjusting, and balancing of systems under this Section with minimum five years documented experience certified by AABC or prequalified as listed below.
- .2 Work shall be performed under the supervision of an AABC certified Test and Balance Engineer, an NEBB Certified Testing, Adjusting and Balancing Supervisor or a registered Professional Engineer experienced in the performance of this work and licensed at the place where the Project is located.
- .3 Prequalified agencies include;
 - .1 National Air Balancing
 - .2 Clark Balancing Ltd.
 - .3 Dynamic Flow Balancing

1.9 PRE-BALANCING CONFERENCE

- .1 Convene one week prior to commencing work of this Section.

1.10 SEQUENCING

- .1 Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

1.11 SCHEDULING

- .1 Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

1.12 CO-OPERATION

- .1 Co-operate with installing Contractor(s) in advising them of specific scheduling requirements for systems verification.
- .2 Provide advice to installing Contractors regarding the location and installation of devices required to permit system balancing and measurements, prior to start of the installation work.
- .3 Coordinate verification of smoke control and automatic sprinkler systems with verification of fire alarm system under Division 26.

2 Products

2.1 REFERENCE STANDARDS

- .1 All equipment required for the verification of equipment and systems shall be furnished by the agency employed to conduct the Mechanical Systems Verification.

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- .2 Testing and measuring equipment used in the verification of the mechanical systems shall be calibrated to give true readings within the accuracy specifications of the equipment used. A certificate of calibration from an independent testing laboratory may be required by the Consultant if there is any reason to suspect that the equipment used is giving erroneous readings. In such an event the verification agency shall reconduct its verifications.
 - .3 All equipment used by the agency in its verification of mechanical systems remains the property/responsibility of the agency and is not included in the supply to the project.

3 Execution

3.1 EXAMINATION

- .1 Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - .1 Systems are started and operating in a safe and normal condition.
 - .2 Temperature control systems are installed complete and operable.
 - .3 Proper thermal overload protection is in place for electrical equipment.
 - .4 Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - .5 Duct systems are clean of debris.
 - .6 Fans are rotating correctly.
 - .7 Fire and volume dampers are in place and open.
 - .8 Air coil fins are cleaned and combed.
 - .9 Access doors are closed and duct end caps are in place.
 - .10 Air outlets are installed and connected.
 - .11 Duct system leakage is minimized.
- .2 Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- .3 Beginning of work represents acceptance of existing conditions in the areas served.

3.2 PREPARATION

- .1 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.
- .2 Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

- .1 Roof Top Unit: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
- .2 Air Outlets and Inlets: Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.

3.4 ADJUSTING

- .1 Ensure recorded data represents actual measured or observed conditions.
- .2 Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- .3 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- .4 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- .5 At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- .6 Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

- .1 Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- .2 Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- .3 Measure air quantities at air inlets and outlets.
- .4 Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- .5 Use branch volume control dampers and splitters to regulate air quantities. Devices at air outlets may be used only to the extent that adjustments do not create objectionable air motion or sound levels.
- .6 Vary total system air quantities by adjustment of fan speeds. Adjust airflow to design quantity. Provide drive changes as required.
- .7 Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- .8 Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan.
- .9 Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- .10 Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- .11 Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- .12 Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 in.wg. (12.5 Pa) positive static pressure near the building entries.
- .13 For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.6 NIL

3.7 VERIFICATION CHECKLIST

- .1 Prepare a series of checklists to record the verification of each item of equipment and each system. Submit a draft of each checklist to the Consultant and the Owner for review and approval. Discuss comments offered the Consultant and Owner and include improvements as directed.
- .2 Checklists shall include the following as a minimum;
 - .1 date(s) of observations and/or tests,
 - .2 a record of the nameplate data for each equipment item and each associated motor,
 - .3 a list of observations appropriate to the equipment item or system with space adjacent to indicate whether the item was satisfactory or unsatisfactory,
 - .4 appropriate space for recording comments and/or instructions given during observations.

3.8 EQUIPMENT VERIFICATION

- .1 Test the operation of all equipment installed under Division 15 according to instructions in appropriate articles of this Division. Advise installing contractor of any required adjustments or replacements to ensure that equipment is operating as intended. Retest equipment after adjustment or replacement.
- .2 Ensure that the Contractor has given proper advance notification to all persons required to be present as tests are conducted. Refer to 15100.
- .3 Instrumentation: verify installation of air filter gauges, pitot traverse stations, and flow-measuring devices ensuring that:
 - .1 Location of points for readings is appropriate to measure what it is intended to measure;
 - .2 The scale range is appropriate to place the normal reading near mid-range of the scale;
 - .3 Proper positioning of instrumentation to allow reading from a convenient location, and for easy access.
- .4 Filters Inspection: visually inspect each filter installation. Verify adjustment of latching devices, installation of end spacers in filter boxes, and proper latching and sealing of access doors. Verify the installation of new (clean) filter media after Contractor's start-up procedures.

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- .5 Pre-start-up Inspection:
 - .1 Verify proper equipment mounting and setting.
 - .2 Verify that control, interlock, and power wiring are complete.
 - .3 Verify proper alignment of motors and drives.
 - .4 Verify proper piping connections and accessories.
 - .5 Verify that lubrication is complete.
 - .6 First Run Observation:
 - .1 Verify direction of rotation.
 - .2 Verify setting of safety controls.
 - .3 Monitor heat build-up in bearings.
 - .4 Check motor loads against nameplate ratings.
 - .7 Equipment Checkout:
 - .1 Verify the proper overload heater sizes.
 - .2 Verify function of safety and operating controls.
 - .3 Verify proper operation of equipment.
 - .4 Report on inspection, observation, and checkout procedures.
 - .8 Motor Rotation: visually inspect and verify the direction of motor rotation. It is possible for motor rotation to have been checked by the electrician when power connections were made on temporary electric power, then when final connections were made to the permanent transformer bank, crossed phasing may reverse the rotation of all three-phase motors on the system.
 - .9 Overload Heaters: verify supply voltage to each equipment. If the applied voltage is different from the motor nameplate, determine whether the applied voltage is within the range allowed under the motor guarantee. If not, take the necessary action to have the Contractor change the motor or the applied voltage. When the voltage is off the nameplate value, but within the allowable range, compute the equivalent amperage at nameplate voltage and compare to the overload heater amperage rating range. Then, consider whether the ambient temperature of the starter is above, below, or the same as the ambient temperature are not the same. Advise the Contractor to use overload heaters of higher range for "hot area" starters or ones of lower range for "cold area" starters to compensate the heater trip point for heat gains or losses with the environment.
 - .10 Alignment of Drives: verify the alignment of drives, belt and direct coupled, and the adjustment of belt tension.
 - .11 Control Diagrams and Sequences: provide for coordination with work under the automatic control systems to have the control diagrams and sequences of operation corrected to "as installed", reflecting changes brought about in response to contract modifications and to the more pragmatic changes in diagrams and sequences to make the installed system control the building systems as intended by the designer.
 - .12 Safety and Operating Control Setpoints: systematically verify the safety and operating controls of equipment, including an operational check of associated control sequences.
 - .13 Fin Straightening: inspect finned surface heat transfer coils for damages fins and advise Contractor of repairs required.
 - .14 Verify that manufacturer's start-up procedures have been performed and that equipment is installed in accordance with the manufacturer's written installation recommendations.
 - .16 Where work is noted to be done in stages a complete air balance and verification report will be required at the end of each stage.

3.9 AIR SYSTEM VERIFICATION

- .1 Review drawings, specifications and installed work to ensure that systems may be properly balanced in accordance with drawings. Advise installing Contractor of any additional requirements for effective balancing.
- .2 In air handling systems which include supply fans with variable speed drives, airflows shall be verified to design with all filters clean and with all filters loaded to filter manufacturer's recommended final (change-out) resistance. Motor and drive capacity to accommodate full range of filter loadings shall be verified.
- .3 In air handling systems which include supply fans without variable speed drives, air filters shall be verified to design airflows with air filters loaded so that the air pressure drop through each filter is equal to the

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- average of the manufacturers listed initial resistance and recommended final (change- out) resistance.
 - .4 Test and record blower rpm for each fan and air handling unit.
 - .5 Test and record motor full load amperes.
 - .6 Make Pitot tube traverse of main supply and obtain operating air quantities at fans.
 - .7 Test and record system static pressures, suction and discharge.
 - .8 Test and record system operating recirculated air quantities.
 - .9 Test and record system operating outside air quantities.
 - .10 Test and record entering drybulb air temperatures (heating and cooling coils).
 - .11 Test and record entering wet bulb air temperatures (heating and cooling coils).
 - .12 Test and record leaving dry bulb air temperatures (heating and cooling coils).
 - .13 Test and record leaving wet bulb air temperatures (cooling coils only).
 - .14 Measure airflow in all main and zone branch supply and return air ducts.
 - .15 Test and record airflow at each diffuser, grille, and register.
 - .16 Witness and verify results of duct leakage tests conducted under section 15810.
 - .17 Tabulate and certify test results on suitable forms and submit Consultant for approval and record.
Identify each diffuser, grille, and register as to location and area. Identify and list size, type, and manufacturer of diffusers, grilles, registers, and all testing equipment. Use manufacturer's rating on all equipment to make required calculations.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Duct work insulation.
- .2 Insulation jackets.

1.3 REFERENCES

- .1 Section 23 01 01: Requirements for references and standards.
- .2 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
- .4 ASTM C553 - Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
- .5 ASTM C612 - Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
- .6 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- .7 ASTM C1071 - Fibrous Glass Duct Lining Insulation(Thermal Sound Absorbing Material).
- .8 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- .9 ASTM E96 - Water Vapour Transmission of Materials.
- .10 ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
- .11 ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .12 NAIMA National Insulation Standards.
- .13 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- .14 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .15 UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
- .16 CGSB-Canadian General Standards Board.
- .17 CAN/CGSB-51.9 Mineral Fiber Thermal Insulation for Piping and Round Ducting.
- .18 CAN/CGSB-51.10 Mineral Fiber Board Thermal Insulation
- .19 CAN/CGSB-51.11 Mineral Fiber Thermal Insulation Blanket.

1.4 SUBMITTALS FOR REVIEW

- .1 Section 23 01 01: Procedures for submittals.
- .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 23 01 01: Procedures for submittals.
- .2 Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Applicator Qualifications: Company specializing in performing the work of this section with a minimum of 6 years documented experience.

1.7 REGULATORY REQUIREMENTS

- .1 Materials: Flame spread/smoke developed rating of 25/50 to the requirements of the Ontario Building Code.

1.8 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 23 01 01: 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 ENVIRONMENTAL REQUIREMENTS

- .1 Section 23 01 01: Environmental conditions affecting products on site.
- .2 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- .3 Maintain temperature during and after installation for minimum period of 24 hours.

2 Products

2.1 GLASS FIBRE, FLEXIBLE

- .1 Manufacturer: Owens Corning Fiberglas
- .2 Other acceptable manufacturers offering equivalent products:
 - .1 Manson
 - .2 Knauf Fiber Glass
 - .3 Schuller
- 3 Insulation: ASTM C553; flexible, noncombustible blanket.
 - .1 'ksi' value : ASTM C518,0.045 at 75.2 °F (24 °C).
 - .2 Maximum service temperature: 250 °F (121 °C).
 - .3 Maximum moisture absorption: 0.20 percent by volume.
- .4 Vapour Barrier Jacket:
 - .1 Kraft paper with glass fibre yarn and bonded to aluminized film.
 - .2 Moisture vapour transmission: ASTM E96; 0.02 perm.
 - .3 Secure with pressure sensitive tape.
- .5 Vapour Barrier Tape:
 - .1 Kraft paper reinforced with glass fibre yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- .6 Outdoor Vapour Barrier Mastic:
 - .1 Vinyl emulsion type acrylic or mastic, compatible with insulation, black colour.
- .7 Tie Wire: Annealed steel, 1/16" (1.5 mm).

2.2 GLASS FIBRE, RIGID

- .1 Manufacturer: Owens Corning Fiberglas Model Vapour-Seal.
- .2 Other acceptable manufacturers offering equivalent products:
 - .1 Manson
 - .2 Knauf Fiber Glass
 - .3 Schuller
 - .4 Substitutions: Refer to Section 01 62 00.
- .3 Insulation: ASTM C612; rigid, noncombustible blanket.
 - .1 'ksi' value : ASTM C518,0.036 at 75.2 °F (24 °C).
 - .2 Maximum service temperature: 250 °F (121 °C).
 - .3 Maximum moisture absorption: 0.20 percent by volume.
 - .4 Density: 48 kg/cu m.
- .4 Vapour Barrier Jacket:

- .1 Kraft paper with glass fibre yarn and bonded to aluminized film.
- .2 Moisture vapour transmission: ASTM E96; 0.04 perm.
- .3 Secure with pressure sensitive tape.

2.3 JACKETS

- .1 Canv as Jacket: UL listed.
 - .1 Fabric: ASTM C921, 220 g/sq m, plain weave cotton treated with dilute fire retardant lagging adhesive.
 - .2 Lagging Adhesive: Compatible with insulation.
- .2 Mineral Fibre (Outdoor) Jacket: Asphalt impregnated and coated sheet, 2.45 kg/sq m.
- .3 PVC Jacket (Indoor):
 - .1 Jacket: ASTM C921, One piece sheet material.
 - .1 Minimum Service Temperature: -31 °F (-35 °C).
 - .2 Maximum Service Temperature: 150 °F (66 °C).
 - .3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
 - .4 Maximum Flame Spread: ASTM E84; 25 or less.
 - .5 Maximum Smoke Developed: ASTM E84; 50 or less.
 - .6 Thickness: 20 mil (0.4 mm) minimum.
 - .2 Colour: standard off-white **OR coloured to suit duct identification**
 - .3 Covering Adhesive Mastic
 - .1 Compatible with insulation, maximum VOC content of 50 g/L.
 - .4 Manufacturer;
 - .1 Ceel-Co 300 series
 - .2 Speedline *Smoke Safe*
- .4 Aluminum Jacket: ASTM B209M.
 - .1 Thickness: 0.40 mm sheet.
 - .2 Finish: Smooth.
 - .3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
 - .4 Fittings: 0.4 mm thick die shaped fitting covers with factory attached protective liner.
 - .5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.015" (0.38 mm) thick aluminum.

2.4 ACCESSORIES

- .1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.
- .2 Vapor retarder lap adhesive shall be water based, fire retardant
- .3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.
- .4 Tie wire shall be of 1/16" (1.5 mm) Ø stainless steel.
- .5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.
- .6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.
- .7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation

3 Execution

3.1 EXAMINATION

- .1 Verify that ductwork has been tested before applying insulation materials.
- .2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- .1 Install duct insulations to TIAC National Installation Standards.
- .2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.
- .3 Insulated ductwork 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.
- .4 Insulated ductwork 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.
- .5 Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces below 3 metres above finished floor: Finish with canvas jacket sized for finish painting.
- .6 Exterior Applications: Provide insulation with vapour barrier jacket. Cover with outdoor jacket finished as specified.
- .7 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.
- .8 Duct and Plenum Liner Application:
 - .1 Adhere insulation with adhesive for 90 percent coverage.
 - .2 Secure insulation with mechanical liner fasteners. Refer to SMACNA 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 DUCT INSULATION

- .1 Insulate new or altered ductwork and re-insulate existing ductwork where insulation has been removed or damaged as follows:

<u>Service</u>	<u>Type</u>	<u>Thickness</u>	
Air supply rectangular/ round	rigid	1"	(25 mm)
Air supply round	flexible	1"	(25 mm)
Exhaust 6' (2m) from outside) rectangular	rigid	3"	(75 mm)
Exhaust 6' (2m) from outside) round	flexible	3"	(75 mm)
Fresh air intake rectangular	rigid	3"	(75 mm)
Exhaust air plenums	rigid	3"	(75 mm)
Ductwork outdoors	rigid	3"	(75 mm)
Rectangular air supply runouts to terminal units <10' (3m) in length	rigid	1"	(25 mm)
Round air supply runouts to terminal units <10' (3m) in length	flexible	1"	(25 mm)
Duct mounted cooling coils	rigid	1 ½"	(40 mm)

- .2 Inline duct silencers shall be insulated in the same manner as ductwork.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Piping insulation.
- .2 Jackets and accessories.

1.3 REFERENCES

- .1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- .3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
- .4 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
- .5 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.
- .6 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
- .7 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- .8 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- .9 ASTM C547 - Mineral Fibre Pipe Insulation.
- .10 ASTM C552 - Cellular Glass Thermal Insulation.
- .11 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.
- .12 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
- .13 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.
- .14 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.
- .15 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.

1.4 SUBMITTALS

- .1 Product Data: Provide product description, list of materials and thickness for each service, and locations.
- .2 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- .1 Materials: Flame spread/smoke developed rating of 25/50 or less to ULC S102 and ASTM E84.

1.6 QUALIFICATIONS

- .1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- .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 ENVIRONMENTAL REQUIREMENTS

- .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 24 hours.

2 Products

2.1 GLASS FIBRE

- .1 Manufacturers:
 - .1 Manufacturer: Owens Corning Fiberglas
- .2 Other acceptable manufacturers offering equivalent products:
 - .1 Manson
 - .2 Knauf Fiber Glass
 - .3 Schuller
- .2 Insulation: ASTM C547; rigid moulded, noncombustible.
 - .1 'ksi' value : ASTM C335, 0.035 at 75°F (24°C).
 - .2 Minimum Service Temperature: -20°F (-28.9°C).
 - .3 Maximum Service Temperature: 302°F (150°C).
 - .4 Maximum Moisture Absorption: 0.2 percent by volume.
- .3 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; 0.02 perm.
 - .3 Secure with self sealing longitudinal laps and butt strips.
 - .4 Secure with outward clinch expanding staples and vapour barrier mastic.
- .4 Tie Wire: 1.3 mm stainless steel with twisted ends on maximum 12" (300 mm) centres.
- .5 Vapour Barrier Lap Adhesive
 - .1 Compatible with insulation.
- .6 Insulating Cement/Mastic
 - .1 ASTM C195; hydraulic setting on mineral wool, VOC content not to exceed 80 g/L.
- .7 Fibrous Glass Fabric
 - .1 Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 - .3 Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
- .8 Indoor Vapour Barrier Finish
 - .1 Vinyl emulsion type acrylic, compatible with insulation, white colour, VOC content not to exceed 250 g/L.
- .9 Outdoor Vapour Barrier Mastic
 - .1 Vinyl emulsion type acrylic, compatible with insulation, white colour.
- .10 Insulating Cement
 - .1 ASTM C449, VOC content not to exceed 80 g/L.

2.2 PHENOLIC INSULATION

- .1 Manufacturers:
 - .1 Manufacturer: Resolco International bv "Insul-Phen"
 - .2 Other Manufacturers: in accordance with 15010.2.3
- .2 Insulation: ASTM C-1126 Phenolic Foam Thermal Insulation, CFC and HCFC free, rigid moulded, noncombustible insulation fabricated in required shapes by Resolco International approved fabricators to ASTM C-450 and C-585.
 - .1 Density: 2.5-lb/ft³ (40-kg/m³)
 - .2 Temperature range: -290°F to +250°F (-129°C to +107°C)
 - .3 Closed cell content: 92%
 - .4 Compressive strength: 29 psi (2 bar)
 - .5 Thermal conductivity: 0.13 BTU-in/hr-ft²-°F (18.72 W-mm/m²-°C)

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- .6 Fire resistance rating: 25/50 to ASTM E84 on plain and faced product up to 3" (75mm) Thick
 - .3 Joint Sealer:
 - .1 vapour barrier type, moisture and water resistant, 97% solids by weight, non-hardening, flexible in temperature range from -5°F to +200°F (-20.5°C to +93.3°C), Daxcel 161D, Fosters 30-45, Childers CP-76.
 - .4 Vapour Barrier Mastic / Reinforcing:
 - .1 Vimasco Vapor-Block, Fosters 30-80, #749 or Childers' Chil-Perm #SP-35, or approved equal with the following minimum requirements:
 - .1 Wet Fammability: No flash to boiling
 - .2 Water Vapor Permeance: Maximum 0.08 US perms
 - .3 Average Non Volatile: 58% by volume
 - .4 Service Temperature Range: -20°F to +190°F (29°C to 88°C)
 - .5 Application: Two Coats
 - .2 The membrane for reinforcement of vapor retardant mastic shall be 6 X 6 or 10 X 10 glass fiber reinforcing mesh, Chil Glas #5 made by Chilers or PC-79 Fabric, 5 X 6 mesh, by Pittsburgh Corning, or approved equal.
 - .5 Vapour Barrier (Indoor Service)
 - .1 Vapor barrier for indoor service shall be ASJ All Service Jacket as manufactured by Compac Corp or Lamtec Corp as per the Resolco UL E84 test reports, constructed from 0.009 mm thick aluminum foil laminated to 30lb. Kraft paper by flame retardant adhesive (VOC content not to exceed 650 g/L for clear or 350 g/L for pigmented). The complete laminated product shall be reinforced with tri directional fiberglass yarn with yarn spacing of 5 per inch.
 - .2 Venture 1555U factory applied zero perm jacket system shall be used in areas of high humidity or where there is a risk of mould/mildew growth.
 - .3 In areas of heavy mechanical abuse or high pressure wash down areas use product for Outdoor Service.
 - .6 Vapour Barrier (Outdoor Service)
 - .1 The vapor barrier used to seal any plain pipe insulation for outdoor service prior to application of cladding shall be Polyguard Insulrap 30 rubberized bitumen adhesive laminated to a 4 mil polyethylene film. Total thickness shall be 30 mils (0.76mm), permeance; 0.015 max, or approved equal.
 - .2 Polyguard 650 LT Liquid Adhesive is required at appliaction temeratures below 50°F (10°C) or with dusty insulation surfaces. As an alternative to the use of Liquid Adhesive, a light pass may be made with a heat gun over the face of the adhesive mass, just prior to application.
 - .3 Peel & Seal, self-stick, aluminum embossed finish; by Polyguard Products may be considered as an alternative, outdoors. It eliminates the need for metal cladding, however, it is recommended for installation above +60°F (+16°C) and in no case, below +40°F (4°C).
 - .4 All outdoor jacket systems shall be banded using 1/2" (12 mm) aluminum banding with wing seals at 12" (300 mm) centers.
 - .7 Fabrication Adhesive
 - .1 Fabriaction adhesive for Insul-Phen shall be H.B. Fuller's SC-1454, a contact adhesive or H.B. Fuller's HL-2278, hot melt adhesive, or approved equal.
 - .8 Pipe and Hanger Supports
 - .1 Pipe suport load bearing insulation shall be fabricated by a Resolco approved fabricator from Resolco CFC & HCFC free heavy density Insul-Phen in 3.75lb/ft³ density in accordance with the table in attachment 1. The upper 1870° section of the support can be fabricated from standard 2.5lb./ft³ density Insul-Phen and 2.5lb./ft³ can be used at the support point up to a certain pipe diameters (contact your local Resolco fabricator or technical rep) with a 12" (300 mm) long saddle.
 - .2 The pipe support insulation shall be supported by a saddle. Stainless steel saddles shall be used where edible food or open product is exposed. For all other applications it is acceptable to use painted, galvanied or carbon steel.

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- .9 PVC Cladding (Indoor Use only)
- .1 The jacketing to provide protection to insulation and vapor barrier shall be 0.030" (0.8 mm) thick Ceel-Co 300 Series UVR PVC Jacketing or Proto LoSmoke 25/50 UVR PVC. Jacketing shall be tough all purpose, UV resistant capable of enduring frequent washing with hot water or other cleaning agents. All joints of PVC jacket shall be solvent welded with Ceeltite or Proto PVC Adhesive. As an alternative a high density (3.75lb) phenolic along with 0.020 PVC jacket can be used.
 - .2 Ceel-Co 300 Series or Proto LoSmoke UVR PVC Jacket .040" (1 mm), or a double wrap of .030" (0.8 mm) thick shall be used where protection from mechanical abuse or high pressure washing is required.
 - .3 A stainless steel diamond-mesh expanded metal lath cage shall be installed with spacers a minimum of 1" (25 mm) away from and over top of the pipe and insulation sealed with PVC Jacket in areas where it is possible for knives, etc. to damage jacket system.
 - .4 In food preparation/hygenic areas cladding must withstand scalding water washdowns; wherever a higher temperature material is required: Proto EXOD (R), a CPVC material, light grey and is rated to +225°F (107°C). EXOD (R) shall be ordered "cut and precurled" for pipe insulation jacket.
- .10 Aluminum Cladding (Outdoor Use only)
- .1 The metal cladding weather barrier to provide protection from weather, mechanical wear or other damage shall be aluminum alloys 3003, 1100 or 3105 meeting ASTM B209 with H-14 temper, 0.016" (0.4 mm) thick with Polysurlyn moisture barrier on the back side. The metal jacketing shall be RPR Incul-mate, Childers Products or approved equal.
 - .2 .016 inch thick aluminum is acceptable for all piping except where excessive abuse is anticipated; use .024" (6 mm) thick. .024" (6 mm) thick shall be used on all equipment as minimum, however .032" (8 mm) thick is preferred.
 - .3 The metal cladding where frequent washing is anticipated, shall be smooth for all piping and horizontal equipment and 1-1/4" (30 mm) corrugated for all vertical equipment above 30" (762 mm) insulation OD. Stucco embossed finish may be used for other areas.
 - .4 Where foot traffic is likely and increased strength of jacket is necessary use rolls of pipe jacketing; Childers Corolon or RPR Rib-Cor, 3/16" (0.2 mm) corrugated in the circumferential direction
- .11 Fastening Accessories
- .1 Tape for fastening plain pipe covering insulation shall be 3/4" (20 mm) Fiberglass reinforced strapping tape made by National Tape Co. or approved equal.
 - .2 Stainless steel type T304/T316 or .020 aluminum strapping for fastening aluminum jacketing outdoors and outer layer of vessel and/or large diameter (above 16 inches O.D.) pipe insulation shall be 1/2" x .020" (15 mm x .5 mm) thick with stainless steel or aluminum wing seals made by RPR Products, Childers Products or approved equal. RPR no. 7 or breather spring 4 inches long made from stainless steel type T305 shall be used for securing large diameter vessels metal jacketing.
 - .3 Polypropylene 1/2" (15 mm) wide, 1/2" (15 mm) thick banding and clips, Q-Band/Q-Clip made by Band-It Inc. shall be used for securing PVC jacketing indoors. The banding shall not be used in food processing areas where bacterial growth is anticipated. Banding may be used for temporary securement until PVC joint adhesive cures. The PVC Jacketing must be complete sealed at all joints to prevent entry of water or moisture. In non food processing areas PVC jacketing should be glued using manufacturers adhesive (VOC content not to exceed 510g/L).
- .12 Inspection Plugs
- .1 NDT Inspection plugs made from EPDM and aluminum metal cap as manufactured by Parker Special Products shall be installed on pipe and equipment requiring frequent inspections. Use 1-1/2" (40 mm) NDT plug for pipe and equipment insulation jacket OD of less than 9" (225 mm). Use 2-1/2" (65 mm) and 3" (75 mm) NDT plug for pipe and equipment between 9" (225 mm) and 24" (600 mm) insulation jacket OD. Use 5" (125 mm) NDT plug for pipe and equipment insulation jacket OD above 24" (600 mm).

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- .13 Expansion/Contraction Joints
.1 Expansion/contraction joint material shall be 1lb/ft³ density fiberglass blanket.

2.3 JACKETS

- .1 PVC Plastic
.1 Jacket: ASTM C921, One piece moulded type fitting covers and sheet material.
.1 Minimum Service Temperature: -31°F (-35°C).
.2 Maximum Service Temperature: 151°F (66°C).
.3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
.4 Maximum Flame Spread: ASTM E84; 25 or less.
.5 Maximum Smoke Developed: ASTM E84; 50 or less.
.6 Thickness: 20 mil (0.4 mm) minimum.
.2 Colour: standard off-white **OR** coloured to suit pipe identification.
.3 Covering Adhesive Mastic
.1 Compatible with insulation, maximum VOC content of 50 g/L.
.4 Manufacturer;
.1 Ceel-Co 300 series
.2 Speedline *Smoke Safe*
.2 Aluminum Jacket: ASTM B209.
.1 Thickness: 0.02" (0.40 mm) sheet.
.2 Finish: Smooth.
.3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
.4 Fittings: 0.02" (0.40 mm) thick die shaped fitting covers with factory attached protective liner.
.5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.01" (0.38 mm) thick aluminum.

2.4 REMOVABLE / REUSABLE INSULATION COVERS

- .1 Material: Teflon coated, woven fibreglass fabric
.2 Weight: 16.5 oz/sq.yd. (± 10%)
.3 Thickness: 0.015" (± 10%)
.4 Colour: Gray
.5 Tensile Strength: 400 x 330 lb. (W x F)
.6 Tarp Tear strength: 60 x 40 lb. (W x F)
.7 Mullen Burst Pressure: 650 psi
.8 Insulation thickness: Match connecting piping
.9 Temperature Range: -67°F to 500°F
.10 Lacing Hooks: Stainless Steel
.11 Tie Wire: 16-ga stainless steel

2.5 ACCESSORIES

- .1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.
.2 Vapor retarder lap adhesive shall be water based, fire retardant
.3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.
.4 Tie wire shall be of 1/16" (1.5 mm) Ø stainless steel.
.5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.
.6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.
.7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

2.6 CELLULAR GLASS

- .1 Manufacturer: Pittsburgh Corning FOAMGLAS.
- .2 Insulation: ASTM C552 "Standard Specification for Cellular Glass Thermal Insulation",
 - .1 'k' Value: 0.039 at 24 degrees C.
 - .2 Maximum Service Temperature: 482 degrees C.
 - .3 Maximum Water Vapour Transmission: 0.1 perm.
 - .4 Maximum Moisture Absorption: ASTM C240, 0.2% by volume.
 - .5 Density: 128 kg/cu m.
- .3 FOAMGLAS® pipe insulation shall be fabricated according to the requirements of ASTM C1639 "Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation".

3 Execution

3.1 EXAMINATION

- .1 Verify that piping has been tested before applying insulation materials.
- .2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- .1 Install piping insulations to TIAC National Installation Standards.
- .2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.
- .3 On exposed piping, locate insulation and cover seams in least visible locations.
- .4 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.
- .5 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 140°F (60°C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
 - .6 For hot piping conveying fluids over 140°F (60°C), insulate flanges and unions at equipment.
- .6 Inserts and Shields:
 - .1 Application: Piping 1-1/2" (40 mm) 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 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - .5 Insert Material: hydrous calcium silicate insulation.
- .7 Finish insulation at supports, protrusions, and interruptions.
- .8 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement.
- .9 Provide integral vapour barrier jacket on insulation on pipe and fittings for exterior applications.
- .10 Provide PVC jacket and fitting covers for pipe in mechanical equipment rooms and where exposed in finished spaces.

- .12 Provide aluminum jacket and fitting covers with seams located on bottom side of horizontal piping for exterior applications, in boiler rooms and where subject to temperatures > 200°F (93°C).
- .11 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 one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- .12 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 jacket with seams located on bottom side of horizontal piping.

3.3 TOLERANCE

- .1 Substituted insulation materials: Thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 PIPE INSULATION

- .1 Insulate new or altered piping with rigid pipe insulation and re-insulate existing piping where insulation has been removed or damaged as follows:

Service	Operating Temperature Range °F (°C)	Pipe Diameter in. (mm)	Insulation Thickness in. (mm)
Cold water (outside building)	0 to 850 (-18 to 454)	All sizes	2 (50)
Condensate (cold)	0 to 850 (-18 to 454)	All sizes	1/2 (13)
Domestic cold water	0 to 850 (-18 to 454)	All sizes	1 (25)
Domestic hot water & hot water recirculation	105 (41) and higher	2 (50) and smaller 2-1/2 (65) and larger	1 (25) 1-1/2 (40)
Sanitary drainage	40 to 55 (4 to 13)	All sizes	1 (25)
Storm drainage	40 to 55 (4 to 13)	All sizes	1 (25)
Hydronic heating (hot water gn glycol/water)	105 to 140 (41 to 60) 105 to 140 (41 to 60) 141 to 200 (61 to 93)	4 (100) and smaller 5 (125) and larger All sizes	1 (25) 1-1/2 (40) 1-1/2 (40)

Note: Phenolic insulation may be used in place of rigid fibreglass pipe insulation, thickness to provide equivalent thermal resistance.

- .2 Insulate with flexible insulation as follows:

Service	Thickness
Horizontal storm and sanitary drainage	1" (25 mm)

- .3 Insulate valves, flanges and pipe connections with removable / reusable insulation covers.
- .4 Wrap butt joints with a 4" (100 mm) strip of fire resistant vapour barrier jacket cemented with lagging adhesive.

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- .5 Where the pipe hanger is around the insulation, provide an insulation protection shield within the pipe saddle. Coordinate with installation of hangers.
 - .6 Insulate all fittings, flanges and valves on pipes to provide equivalent insulation to that on adjoining pipe.
 - .7 Continue insulation through sleeves including specified finish.
 - .8 Cut back covering on strainers and finish off to expose removable head insulation.
 - .9 Cover expansion joints first with 24 gauge (0.7 mm) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.
 - .10 Protect insulation with protection saddles where insulated pipe is supported by rollers.
 - .11 Insulate pipe hangers supporting new piping carrying water at 70°F (21°C) or less to prevent condensation. Extend insulating material along hanger rod to height 4 times thickness of insulation. Seal insulation with vapourproof sealant.
 - .12 Extend pipe insulation and covering through walls, floors, ceilings, and concrete beams, unless indicated otherwise on drawings. protect exposed insulation extending through floors with 4" (100 mm) wide strip of 18 gauge (1.3 mm) galvanized iron.
 - .13 Pack annular space between pipe sleeves and piping or pipe covering with glass fibre insulation or rockwool insulation. In fire rated assemblies use Dow Silicon RTV or other ULC listed materials. Seal exposed insulation with mastic.
 - .14 Recover exposed surfaces of insulated piping installed in exposed areas, mechanical rooms, and equipment rooms with PVC jacketing and PVC fitting covers installed in accordance with manufacturers instructions.
 - .15 Insulate and cover exposed surfaces of waste connections, traps, hot and cold supply risers and valves at each lavatory and sink designated for "handicapped" or "barrier free" use with: PVC insulated fitting covers specifically designed for this application. Vinyl material is not to exceed flame spread rating of 150, and if intended to be used in high buildings, its smoke developed classification does not exceed 300. Zeston or other equivalent material. or foamed plastic type insulation finished with two coats of Armstrong Armflex or other equivalent material.
 - .16 Provide aluminum metal cladding over the insulation on the following services;
 - .1 All exposed piping located outdoors.
 - .17 Insulate sprinkler and standpipe main from take-off from domestic water to a point approximately 6 feet (1800 mm) after electrically supervised valve.
 - .18 Oversize insulation of Domestic hot water piping complete with heating cable for pipe sizes 1-1/4" (35 mm) dia. and smaller by 1/4" (6 mm) in inside diameter to allow for installation over heating cable.

3.6 REFRIGERATION PIPE INSULATION

- .1 Insulate all refrigerant suction and hot gas piping and fittings with flexible foamed plastic pipe insulation. Insulation shall fit pipe. Thickness shall be as follows: 1/2" (13 mm) thick for pipe 1" (25 mm) O.D. and smaller; 3/4" (20 mm) thick for pipe 1-1/8" (28 mm) to 2" (50 mm) O.D.; 1" (25 mm) thick for pipes 2-1/8" (54 mm) O.D. and larger.
- .2 Slip insulation on to tubing before tubing sections and fittings are assembled. Keep slitting of insulation to a very minimum. Seal all joints in the insulation with Armaflex 520 BLV. Insulate flexible pipe connectors.
- .3 On insulation exposed outside the building, place "slit" joint seams on bottom of pipe and provide two coats of grey Armaflex finish. Extend insulation through pipe support clamps. Provide a 6" (150 mm) long, 20 gauge (1.1 mm) galvanized steel sleeve around pipe insulation at each support.

End of Section

1. Furnace & Condensing Unit

1.1 Model Number

- .1 Furnace: Carrier 59MN7A100V21-22 and cased coil CNPVP6024ALA with vent kit KGAVT0801CVT and thermostatic expansion valve KSATX0501PUR. Thermostat: SYSTXCCITN01-A.
- .2 Condensing Unit: Carrier 24ANB160A003.

Basis of design is Carrier, alternate products meeting the specifications and efficiency by York & Trane are acceptable.

2. Product Data

The 59TP6A Multipoise Variable- Speed Condensing Gas Furnace features the two-stage Performance™ System. The Comfort Heat technology two-stage gas valve is at the heart of the comfort provided by this furnace, along with the variable-speed ECM blower motor, and two-speed inducer motor. With an Annual Fuel Utilization Efficiency (AFUE) up to 96.5%, the performance™ Series two-stage gas furnaces provides exceptional savings when compared to standard gas furnaces. This performance Gas Furnace also features 4-way multipoise installation flexibility, and is available in eight model sizes. The 59TP6A can be vented for direct vent/two-pipe, ventilated combustion air, or single-pipe applications. All units meet California Air Quality Management District emission requirements. All sizes are design certified in Canada.

2.1 Standard Features

- .1 All sizes meet ENERGY STAR Version 4.0 criteria for gas furnaces:95+AFUE; AMACF electrical rating; 2% or less cabinet airflow leakage.
- .2 Quiet operation. Compare for yourself at HVACpartners.com.
- .3 Ideal height 35" (889mm) cabinet: short enough for taller coils, but still allows enough room for service.
- .4 Silicon Nitride Perfect Light™ Hot Surface Igniter.
- .5 ComfortFan™ technology allows control of continuous fan speed from a compatible thermostat.
- .6 4-way multipoise design for upflow, downflow or horizontal installations, with unique vent elbow and optional through-the-cabinet downflow venting capability.
- .7 Full-featured variable-speed blower motor, two-speed inducer motor, and two-stage gas valve.
- .8 Self-diagnostics.
- .9 Adjustable blower speed for cooling, continuous fan, and dehumidification.
- .10 Aluminized-steel primary heat exchanger.
- .11 Stainless-steel condensing secondary heat exchanger.
- .12 Factory-configured ready for upflow applications.
- .13 Fully-insulated casing including blower section.
- .14 Direct-vent/sealed combustion, single-pipe venting or ventilated combustion air.
- .15 Installation flexibility: sidewall or vertical vent.

- .16 Certified to leak 2% or less of nominal air conditioning CFM delivered when pressurized to 1-in. Water column with all present air inlets, air outlets, and condensate drain port(s) sealed.

2.2 Features and Benefits

.1 Comfort Heat Technology[®]

This feature with Adaptive Control is proprietary function that promotes homeowner comfort through two stages of heating. This Carrier furnace offers a patented algorithm that continually monitors and adjusts furnace operation by looking at both current and past conditions to determine the most effective stage of heating and the amount of time to run each stage, every cycle.

.2 SmartEvap[™] Technology

When paired with a compatible thermostat, this dehumidification feature overrides the cooling blower off-delay when there is a call for dehumidification. By deactivating the blower off-delay, SmartEvap technology prevents condensate that remains on the coil after a dehumidification cycle from re-humidifying throughout the home. This results in reduced humidity and a more comfortable indoor environment for the homeowner.

Unlike competitive systems, SmartEvap technology only overrides the cooling blower off delay when humidity control is needed. Once humidity is back in control, Smart Evap re-enables the energy-saving cooling blower off-delay.

.3 ComfortFan[™] Technology

Sometimes the constant fan setting on a standard furnace system can actually reduce homeowner comfort by providing too much or too little air! Fan On Plus technology improves comfort all year long by allowing the homeowner to select the continuous fan speed of their choice using a compatible thermostat.

.4 Power Heat[™] Igniter

Carrier's unique SiN igniter is not only physically robust but it is also electrically robust. It is capable of running at line voltage and does not require complex voltage regulators as do other brands. This unique feature further enhances the gas furnace reliability and continues Carrier's tradition of technology leadership and innovation in providing a reliable and durable product.

.5 Full-Featured, Variable Speed Motors

Our variable-speed ECM (Electronically Commutated Motor) optimizes comfort levels in the home year round; features such as passive/active dehumidification, ramping profiles, and quiet operation. They can provide cooling match enhancements to increase the effective SEER of select Carrier air conditioner or heat pump system. This motor does not report back RPM and static pressure to enable static pressure reporting to the UI or zoning system, which is required for zoning, active filter monitoring and system static pressure reporting.

.6 Reliable Heat Exchanger Design

The aluminized steel, clam shell primary heat exchanger was re-engineered to achieve greater efficiency out of a smaller size. The first two passes of the heat exchanger are based on the current 80% product, a design with more than ten years of field-proven performance and success. These innovations, paired with the continuation of a crimped, no-weld seam create an efficient, robust design for this essential component.

The condensing heat exchanger, a stainless steel fin and tube design, is positioned in the furnace to extract additional heat. Stainless steel coupling box componentry between heat exchangers has exceptional corrosion resistance in both natural gas and propane applications.

.7 Optional Media Filter Cabinet

Enhanced indoor air quality in the home is made easier with our media filter cabinet. When installed as a part of the system, this cabinet allows for easy and convenient addition of Carrier high efficiency air filter.

.8 4-Way Multipoise Design

One model for all applications – there is no need to stock special downflow or horizontal models when one unit will do it all. The new heat exchanger design allows these units to achieve the certified AFUE in all positions.

.9 Direct or Single-pipe Venting, or Optional Ventilated Combustion Air

This furnace can be installed as a 2-pipe (Direct Vent) furnace, in an optional ventilated combustion air application, or in single-pipe, non-direct vent applications. This provides added flexibility to meet diverse installation needs.

.10 Sealed Combustion System

This furnace brings in combustion air from outside the furnace, which results in especially quiet operation. By sealing the entire combustion vestibule, the entire furnace can be made quieter, not just the burners.

.11 Insulated Casing

Foil-faced insulation in heat exchanger section of the casing minimizes heat loss. The acoustical insulation in the blower compartment reduces air and motor noise for quiet operation.

.12 Monoport burners

The burners are specially designed and finely tuned for smooth, quiet combustion and economical operation.

.13 Bottom Closure

Factory-installed for side return; easily removable for bottom return. The multi-use bottom closure can also serve for roll-out protection in horizontal applications, and act as the bottom closure for the optional return air base accessory.

.14 Certifications

This furnace is CSA (AGA and CGA) design certified for use with natural and propane gases. The furnace is factory-shipped for use with natural gas. A CSA listed gas conversion kit is required to convert furnace for use with propane gas. The efficiency is AHRI efficiency rating certified. This furnace meets California Air Quality Management District emission requirements.

3. GUIDE SPECIFICATIONS GENERAL 24ABB

3.1 System Description

Outdoor-mounted, air-cooled, split-system air conditioner unit suitable for ground or rooftop installation. Unit consists of a hermetic compressor, an air-cooled coil, propeller-type condenser fan, and a control box. Unit will discharge supply air upward as shown on contract drawings. Unit will be used in a refrigeration circuit to match up to a packaged fan coil or coil unit.

3.2 Quality Assurance

1. Unit will be rated in accordance with the latest edition of ARI Standard 210.
2. Unit will be certified for capacity and efficiency, and listed in the latest ARI directory.
3. Unit construction will comply with latest edition of ANSI/ ASHRAE and with NEC.

4. Unit will be constructed in accordance with UL standards and will carry the UL label of approval. Unit will have c-UL approval.
5. Unit cabinet will be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hr salt spray test.
6. Air-cooled condenser coils will be leak tested at 150 psig and pressure tested at 450 psig.
7. Unit constructed in ISO9001 approved facility.

3.3 Delivery, Storage, and Handling

1. Unit will be shipped as single package only and is stored and handled per unit manufacturer's recommendations.

3.4 Warranty (for inclusion by specifying engineer)

1. U.S. and Canada only.

4. PRODUCTS

AIR-COOLED, SPLIT-SYSTEM AIR CONDITIONER 24ABB 1-1/2 TO 5 NOMINAL TONS

4.1 Equipment

1. Factory assembled, single piece, air-cooled air conditioner unit. Contained within the unit enclosure is all factory wiring, piping, controls, compressor, refrigerant charge Puronr (R-410A), and special features required prior to field start-up.

4.2 Unit Cabinet

1. Unit cabinet will be constructed of galvanized steel, bonderized, and coated with a powder coat paint.

4.3 Fans

1. Condenser fan will be direct-drive propeller type, discharging air upward.
2. Condenser fan motors will be totally enclosed, 1-phase type with class B insulation and permanently lubricated bearings. Shafts will be corrosion resistant.
3. Fan blades will be statically and dynamically balanced.
4. Condenser fan openings will be equipped with coated steel wire safety guards.

4.4 Compressor

1. Compressor will be hermetically sealed.
2. Compressor will be mounted on rubber vibration isolators.

4.5 Condenser Coil

1. Condenser coil will be air cooled.
2. Coil will be constructed of aluminum fins mechanically bonded to copper tubes which are then cleaned, dehydrated, and sealed.

4.6 Refrigeration Components

1. Refrigeration circuit components will include liquid-line shutoff valve with sweat connections, vapor-line shutoff valve with sweat connections, system charge of Puronr (R-410A) refrigerant, and compressor oil.
2. Unit will be equipped with filter drier for Puron refrigerant.

End of Section

1 General

1.1 General Requirements

- .1 Comply with General Requirements of Section 23 01 01.

1.2 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 Check valves.
 - .5 Circuit balancing valves
 - .6 Drain valves.

1.3 References

- .1 ASME -Welding and Brazing Qualifications.
- .2 ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
- .3 ASME B16.5 Pipe Pumps & Fittings.
- .4 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .5 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .6 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
- .7 ASME B31.1 - Code for Power Piping.
- .8 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .9 A183 Carbon Steel Track Bolts and Nuts.
- .10 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- .11 ASTM B32 - Solder Metal.
- .12 ASTM B88 - Seamless Copper Water Tube.
- .13 ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- .14 ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- .15 ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
- .16 ASTM D2310 - Machine-Made Fibreglass' (Glass Fibre-Reinforced Thermosetting Resin) Pipe.
- .17 ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- .18 ASTM D2467 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- .19 ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
- .20 ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- .21 ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- .22 ASTM D2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
- .23 ASTM D3309 - Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems.
- .24 ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- .25 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- .26 ASTM F876 - Crosslinked Polyethylene (PEX) Tubing.
- .27 ASTM F877 - Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems.

1.4 Submittals

- .1 Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- .2 Welders Certificate: Include welders certification of compliance with ASME SEC 9.
- .3 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining. procedures.

1.5 Project Record Documents

- .1 Record actual locations of valves.

1.6 Operation and Maintenance Data

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

1.7 Qualifications

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Installer: Company specializing in performing the work of this section with minimum 3 years documented experience.
- .3 Welders: Certify to ASME SEC 9.

1.8 Regulatory Requirements

- .1 Conform to ASME B31.9 code for installation of piping system.
- .2 Welding Materials and Procedures: Conform to ASME SEC 9 and applicable provincial labour regulations.
- .3 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.9 Delivery, Storage, and Handling

- .1 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- .2 Provide temporary protective coating on cast iron and steel valves.
- .3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 Environmental Requirements

- .1 Do not install underground piping when bedding is wet or frozen.

1.11 Extra Materials

- .1 Provide two repacking kits for each size and valve type.

2 Products

2.1 Valves - General

- .1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
- .2 Provide valves of the same manufacturer where possible.
- .3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
- .4 Valid CRN (Canadian Registration Number) required for each valve.
- .5 Materials:
 - .1 Bronze: ASTM B62 or B61 as applicable
 - .2 Brass: ASTM B283 C3770
 - .3 Cast Iron: ASTM A126 Class B
- .6 End Connections:
 - .1 Threaded ends: ANSI B1.20.1
 - .3 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
 - .4 Face-to-face dimensions: ANSI B16.10
- .7 Design and Testing:
 - .1 Bronze Gate & Check valves: MSS-SP-80
 - .2 Ball Valves: MSS-SP-110
 - .3 Cast Iron Gate Valves: MSS-SP-70
 - .4 Cast Iron Globe Valves: MSS-SP-85

- | | | |
|----|---|-----------|
| .5 | Cast Iron Check: | MSS-SP-71 |
| .6 | Butterfly Valves: | MSS-SP-67 |
| .8 | First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products include: | |
| .1 | Kitz. | |
| .2 | Crane, Jenkins | |
| .3 | Conbraco. | |
| .4 | Nibco | |
| .5 | Or approved equal. | |

2.2 Hydronic Systems To 150 PSIG, Above Ground

- | | | |
|-----|---|---|
| .1 | Nominal Operating Pressure | 125 psig |
| .2 | Design Pressure | 150 psig |
| .3 | Test Pressure | 225 psig |
| .4 | Design Temperature | 350°F |
| .5 | Corrosion Allowance | 0.0625 in. |
| .6 | Steel Pipe | ASTM A53 Gr. B or ASTM A106 Gr. B, schedule 40, black steel, seamless |
| .7 | Joints, 2" and smaller | screwed |
| .8 | Screwed Fittings | 150 Lb. malleable iron |
| .9 | Unions | Cl.150, ASTM A-47 malleable iron, ASTM A-153 galvanized, ANSI B2.1 threads. |
| .10 | Joints, 2-1/2" and larger | welded, with flanges at connections to equipment |
| .11 | Butt weld fittings | ASTM A234 Gr. WFB |
| .12 | Flanges | ASTM A105, Class 150, raised face, weld neck or slip on |
| .13 | Bolts | ASTM A307 C.S. bolts, sq. head; ASTM A563 nuts, hex head |
| .14 | Gaskets | 1/16" (1.6 mm) thick preformed non-asbestos graphite fibre. |
| .15 | Copper Tubing, 2" and Smaller | ASTM B88, Type L, hard drawn. |
| .16 | Joints: | Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220°C to 280°C. |
| .17 | Fittings: | ASME B16.18, cast brass, or ASME B16.22, solder wrought copper |
| .18 | Dielectric Unions | Union with galvanized or plated steel threaded end, |
| .19 | Valves, 2" and smaller | ASTM A105 |
| | Gate Valves (Isolating) | 300 psig non-shock WOG, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz #25 |
| | Globe Valves (Throttling) | 300 psig non-shock WOG, ASTM B62 bronze body, composition (Teflon) disc, rising stem, bronze trim, threaded ends, Kitz #09 |
| | Check Valves (Backflow) | 300 psig non-shock WOG, ASTM B62 bronze body, Y-pattern horizontal, swing type disc, threaded ends, Kitz #29 |
| | Ball Valves (Drain) | 600 psig non-shock WOG, forged brass, 2-piece, chrome ball and stem, full port, blow-out proof PTFE seats & stem, lever handle, threaded ends, Kitz #68AC. |
| .20 | Valves, 2-1/2" and larger | ASTM A216 WCB |
| | Gate Valves (Isolating) | 200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, solid wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #72. |
| | Globe Valves (Throttling) | 200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, bevelled wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #76. |
| | Check (Backflow) | 200 psig non-shock WOG, ASTM 126 Class B cast iron body, bolted cover, bronze mounted, swing type disc, flanged ends, Kitz #78 |
| .21 | Provide stem extensions for insulated piping. | |

- .22 Provide gear operator and chain on valves installed above 10-ft AFF.
- .23 Strainers, 2" and smaller Class 250, 400 psig WOG, cast iron body, Y-pattern, screwed cap and ends, A167 304 stainless steel screen with 1/32" perforations. Mueller Steam 11M.
- .24 Strainers, 2-1/2" and larger Class 250 psig non-shock WOG, cast iron, Y-pattern, bolted flange cover, blow-out plug, A167 304 stainless steel screen with 1/32" perforations, flanged ends, Mueller Steam 752.

2.5 Equipment Drains and Overflows

- .1 Copper Tubing: ASTM B88, Type M and DWV, hard 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 4428°F to 536°F (220°C to 280°C).

2.6 Circuit Balancing Valves

- 1. Circuit Balancing Valves; 2" (50 mm) and smaller
 - .1 Screwed connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy. Each valve shall be such that when installed in any direction, it will not affect flow measurement.
 - .2 Valves shall provide the following functions:
 - .1 Precise flow measurement.
 - .2 Precision flow balancing.
 - .3 Positive shut off with no drip seat and teflon disc.
 - .4 Drain connection with protective cap.
 - .3 Valves shall have four 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
 - .4 Valves shall be shipped in a 4.5 R factor polyurethane container that shall be used as insulation after valve is installed.
 - .5 Provide valves suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (121°C).
 - .6 Acceptable Products: S.A. Armstrong CRV I indicated or Tour & Anderson STA-D or Newman Hattersley.
- 2. Circuit Balancing Valves 2 1/2" (65 mm) and larger
 - .1 Flanged, line size connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy.
 - .2 Valves shall provide the following functions:
 - .1 Precise flow measurement.
 - .2 Precision flow balancing.
 - .3 Positive shut off with no drip seat and teflon disc.
 - .3 Valves shall have twelve 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
 - .4 Valves shall be suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (120°C).
 - .5 Acceptable Products: S.A. Armstrong CBV II indicated or Tour & Anderson STA-F or Newman Hattersley.

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 15515.

3.2 Applications

- .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 Where permitted, install grooved mechanical couplings and fasteners in accessible locations.
- .3 Install 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 Provide non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- .5 Provide pipe hangers and supports to CSA B51 unless indicated otherwise.
- .6 Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- .7 Use globe valves for throttling, bypass, manual flow control services, for balancing & in bypass around control valves.
- .8 Use spring loaded check valves on discharge of condenser water pumps.
- .9 Use wafer check valves where required to suit space and or weight limitations
- .10 Use 3/4 inch (20 mm) gate or ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.
- .11 Use lug end butterfly valves to isolate equipment..
- .12 Butterfly valves may be used isolation and throttling duty for large pipe sizes 2-1/2" (65 mm) and above.
- .13 Gasket material shall be Grade 'E' EPDM compound conforming of ASTM D2-2000 and suitable for an operating temperature range of -34°C to 110°C.
- .14 Small runouts, size 3/4" (20 mm) and less for extension of domestic make-up piping may be constructed using hand drawn copper tube type 'K' or "L" and comply to ASTM B88.

3.3 Installation

- .1 Install to manufacturer's instructions.
- .2 Install heating water, glycol, chilled water, condenser water piping to CSA B51.
- .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.
- .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 4" (100 mm).
 - .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 slab.
- .10 Pipe Hangers and Supports:
 - .1 Install to CSA B51.
 - .2 Support horizontal piping as scheduled.
 - .3 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
 - .4 Place hangers within 12" (300 mm) of each horizontal elbow.
 - .5 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment. Design hangers for pipe

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- 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.
 - .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.
 - .11 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
 - .12 Provide access where valves and fittings are not exposed.
 - .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 (VOC content not to exceed 250 g/L) to welds.
 - .15 Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
 - .16 Install valves with stems upright or horizontal, not inverted.
 - .17 Air vents shall be selected to suit the system operating pressures and shall be automatic and complete with isolating valves.
 - .18 All strainers 1-1/2" & larger shall be fitted with chain valves.
 - .19 Unless specified otherwise, drain piping shall be sloped down in the direction of flow not less than 1" in 40 feet.
 - .20 Eccentric reducers shall be provided to keep the bottom of sloped piping aligned in order to minimize risk of water hammer and to facilitate drainage.
 - .21 Valves shall be installed with stems upright or angled 45 deg. above horizontal unless instructed otherwise.
 - .22 Pipe all discharge from temp. & safety relief valves to a point of safe discharge directly into a floor drain, hub drain or safe outdoor location.

3.4 Equipment Connections

- .1 Install unions or flanges at connections to all equipment and specialty components.
- .2 Arrange piping connections to allow ease of access and removal of equipment.
- .3 Align and independently support piping adjacent to equipment connections in order to prevent piping stresses from being transferred to equipment.
- .4 Piping reducers shall be used where equipment connections differ from pipe sizes indicated. The use of bushings will not be permitted.
- .5 Install removable sections of pipe 12" (300 mm) spool pieces on the suction side of pumps and where needed for ease of maintenance.

3.5 Valves, Cocks and Faucets

- .1 Use valves of line size unless noted otherwise.
- .2 Provide isolating valves in each branch from the main line and where indicated.
- .3 Provide isolating valves at all equipment connections.
- .4 Provide globe valves or ball valves complete with memory stop at the discharge of each pump and where valves are used for regulating or throttling purposes.
- .5 Provide 1/2" (13 mm) brass hose bibbs at all low points of each system, where the system cannot be drained through the main floor or return piping.
- .6 Where new valves are installed to replace existing valves and it is impractical to shut-down and drain the entire system, valves shall be replaced using pipe freezing techniques.

3.6 Hydronic Specialties

- .1 Air Vents
 - .1 Provide 1" (25 mm) diameter air vent chamber at each riser feeding terminal units. Install chambers as high as possible within unit, and provide manual air vent connected to air chamber by flexible tubing.
 - .2 Provide a float type automatic air vent at any high points of hot water supply and return piping not vented through a convactor etc. and at high point of piping for each hot

water coil. The discharge of air vent shall terminate over a floor drain in mechanical rooms or over a sink in service rooms. A shut-off valve shall be provided on each automatic air vent and an access door and frame shall be provided for air vents located above ceilings.

- .2 Automatic Feed Valves: provide automatic feed valve on the cold water make-up line to each new hot water heating system.
- .3 Air Cushion Tanks
 - .1 Provide air cushion tanks of size noted where indicated.
 - .2 Provide housekeeping pad for floor mounting of tank.
 - .3 Terminate drainout line at nearest funnel floor drain, or service sink.
 - .4 Adjust charge to system static pressure at point of connection plus 5 psi (35 kPa).
- .4 Air Eliminators: provide an air eliminator at each new air cushion (expansion) tank.
- .5 Circuit Balancing Valve (CBV): provide a CBV in each branch serving a heating and/or cooling terminal unit and where indicated on drawings. Installation shall be in accordance with manufacturer's installation instructions. Ensure that manufacturer's recommended clearances are maintained to minimize turbulence and to promote accuracy.
- .6 Supply and install threaded couplings or half coupling for flow switches that are supplied under Section 15900.
- .7 Install flow switches as supplied under Section 15900.

3.7 Testing and Inspection

- .1 Test liquid heat transfer piping hydrostatically at not less than 150% of operating pressure or not less than 125 psi (860 kPa) whichever is the greater. Test period shall be not less than six (6) hours duration during which time each joint shall be inspected, given a sharp tap with a hammer and checked for leaks.
- .2 Arrange and pay for inspection by authorities having jurisdiction.

3.8 Adjusting and Balancing

- .1 Instruments used for this work shall be accurately calibrated and maintained in good working order, and shall include:
 - .1 one set of pressure gauges and fittings.
 - .2 dry bulb thermometer.
 - .3 wet bulb thermometer.
 - .4 thermocouple unit and thermocouple.
 - .5 set of balancing cock adjustment wrenches.
 - .6 portable field flow meter.
- .2 Prepare the liquid heat transfer systems as follows:
 - .1 Install any additional devices required for effective balancing as advised by the Systems Verification Agency.
 - .2 Open all valves, and return line balancing cocks.
 - .3 Remove and clean all strainers.
 - .4 Check pump rotation.
 - .5 Check expansion tanks to make sure they are not air bound and that the system is full of water.
 - .6 Check all air vents at high points of water systems to make sure they are installed properly and are operating freely. Make certain all air is removed from circulating system.
 - .7 Set all temperature controls so that all coils are calling for full cooling. This should close all automatic bypass valves at coil and chillers. To balance hot water coils, set systems to call for full heating.
 - .8 Check operation of automatic bypass valve.
 - .9 Check and set operating temperature of heat exchangers to design requirements.
- .3 Balance the liquid heat transfer systems as follows:
 - .1 Complete air balance must have been accomplished before water balance is begun.
 - .2 Set chilled water, hot water and glycol pumps to proper gpm delivery.
 - .3 Adjust flow of hot water through heat exchangers.
 - .4 Check leaving water temperatures and return water temperatures, and pressure drop through heat exchangers. Reset to correct design temperatures.
 - .5 Check water temperature at inlet side of cooling and heating coils. Note rise or drop of

-
- temperatures from source.
 - .6 Balance each chilled water and hot water coil.
 - .7 Upon completion of flow readings and coil adjustments, mark all settings and record all data.
 - .8 After making adjustments to coils, recheck settings at pumps, and heat exchangers. Readjust if required.
 - .9 Install pressure gauges on each coil, then read pressure drop through coil at set flow rate on call for full cooling and full heating. Set pressure drop across bypass valve to match coil full flow Pressure drop.
 - .10 Check and record the following items at each cooling and heating element:
 - .1 Inlet water and air temperature.
 - .2 Leaving water and air temperature.
 - .3 Pressure drop of each coil.
 - .4 Pump operating suction and discharge pressures and final t.d.h.
 - .5 Pressure drop across bypass valve.
 - .6 All mechanical specifications of pumps.
 - .7 Rated and actual running amperage of pump motor.
 - .4 After completion of adjusting and balancing and submittal of records notify the Systems Verification Agency and the Consultant and assist in verifications. If systems fail verification, readjust and balance systems to the satisfaction of the Consultant.

End of Section

1 General

1.1 Quality Assurance

- .1 Comply with Provincial Regulations and have CSA approval.

1.2 Submittals

- .1 Provide shop drawings and schedules of manufactured products for review and inclusion in Operating and Maintenance Manuals as per Section 23 10 00.

2 Products

2.1 Automatic Air Vents

- .1 Wallfin, Convectors, Radiators:
 - .1 Float-operated, vertical mounting, 1/8" I.P. male connection, designed for pressures up to 50psi, 3-3/4" x 9/16", bright brass finish.
 - .2 Acceptable Manufacturers:
 - .1 Maid-O-Mist #67
 - .2 Honeywell FV180
 - .3 Taco 400-4
 - .4 Armstrong
- .2 Pipe Mains & Lines, Mechanical Rooms, Equipment, Coils, Ceilings spaces and all other spaces except noted above:
 - .1 Self-closing, float-operated, vertical mounting, 1/4" I.P. male connection, designed for pressures up to 150psi, 4-3/8" x 2-1/4", bright brass finish.
 - .2 Acceptable Manufacturers
 - .1 Maid-O-Mist #71
 - .2 Honeywell FV180
 - .3 Taco 400-4
 - .4 Armstrong

2.2 Air Eliminator

- .1 Heavy duty.
- .2 Acceptable Manufacturers:
 - .1 Armstrong 1-AV
 - .2 Spirax Sarco 13WS
 - .3 ITT

2.3 Air Separator

- .1 Air separator shall have tangential inlet nozzles.
- .2 The air separator shall be designed and constructed in accordance with Section VIII, Div 1 of the ASME Boiler and Pressure Vessel Code.
- .3 The unit shall be fitted with an NPT vent connection (for connection to a compression tank or an air vent).
- .4 An additional NPT tapping shall be provided on the bottom of the air separator to facilitate blow-down.
- .5 2" to 3" models should be supplied with a cast iron body and NPT system connections, while 4" to 6"

models should be supplied with a cast iron body and ANSI flanges. 8" to 24" models are to be supplied with a fabricated steel body and carbon steel ANSI flanges.

.6 Acceptable Manufacturers:

- .1 Armstrong Vortex Model VA
- .2 ITT/Bell & Gossett

2.4 Flow Indicators (Water)

- .1 Single Double tempered glass window, bronze body, ABS impeller.
- .2 Suitable for pressure twice that of working pressure, minimum 125 psig.
- .3 Suitable for temperature 200 deg F.
- .4 Equal to Ashland Filter-Mate 304SS.
- .5 Supplied under Section 23 20 00.

2.5 Strainers

- .1 Sizes 50mm (2") and under: Screwed brass or iron body, Y pattern with 0.8mm stainless steel perforated screen.
- .2 Sizes 63mm to 100mm (2½" to 4)": Flanged iron body, Y pattern with 1.2mm stainless steel screen.
- .3 Screen free area shall be minimum three times area of inlet pipe. Provide valved drain and hose connection off strainer bottom.
- .4 Y-Type Strainer shall consist of ductile iron body, Type 304 stainless steel cylindrical removable baskets with 1/16" (1,6mm) diameter perforations and 41% open area 2"-3" strainer sizes or 1/8" (3,2mm) diameter perforations and 40% open area 4"-12" strainer sizes.

2.6 Make-Up Water Meter

- .1 Supply a water meter for make-up water feed for hydronic boiler system.
- .2 Meter shall be certified to NSF/ANSI 372 and NSF/ANSI 61 with maximum operating water pressure of 150 psi (1034 kPa) and maximum operating water temperature of 80°F (27°C).
- .3 Water meter to consist of: a register; a corrosion-resistant lead free, high-copper alloy maincase; and a nutating disc measuring chamber. The measuring chamber of nutating disc technology design to be made from proprietary synthetic polymer or acceptable corrosion-resistant materials.
- .4 Equal to Neptune T-10 or Badger Recordall Disc Series.

2.7 Magnetic Flow Meter

- .1 Supply a magnetic flow meter station comprising of a pipe mounted flowtube and a remote wall mounted transmitter. Operating temperature shall be 4.5C to 95C (40F to 203F) and flow range shall be 0 to 1,900 L/min (0 to 500 usgpm).
- .2 Flow meter station shall be equal to Rosemount Series 8700, distributed by Lakeside Process Controls, Mississauga, Ontario.
- .3 Flow tube shall be Rosemount #8705, flanged (ANSI Class150) to suit adjacent piping, constructed of nonmagnetic stainless steel with a Teflon (PTFE) liner suitable for working temperatures of 29C to 177C (-20F to 350F). Sensor electrodes to be 316 stainless steel equipped with an attached junction box that is NEMA 4 protected.
- .4 Transmitter shall be Rosemount #8712E, suitable for 120V power supply and is wall mounted in the boiler room. Transmitter to be complete with local operator interface (keypad and digital display of flow), diagnostic functions including calibration verification, NEMA 4X and IP65 enclosure, 4 to 20 mA output.
- .5 Flow sensor and transmitter accuracy is + 0.25% of flow rate + 1.5 mm/s for velocities up to 12 m/s (40 ft/s).
- .6 Provide communication 'WHIP', contained in conduit, that connects the wall mounted

transmitter and flowtube sensor. WHIP to be provided by Lakeside.

PART 3 - EXECUTION

3.1 Automatic Air Vents

- .1 Install size as specified herein and in locations as per drawings, at all system high points and as required for complete air purging.
- .2 Where large air quantities can accumulate, provide enlarged air collection standpipe.
- .3 Provide ball valve of size to match air vent I.P connection under each air vent. Shut off valve is to allow isolation, removal, and service of fitting.

3.2 Air Separator

- .1 Provide on suction side of system circulation pump and connect to expansion tank.
- .2 Install high and/or away from access routes so as not to interfere with access routes. If they are installed in access routes the bottom of the unit must be minimum 8' above finished floor.

3.3 Strainers

- .1 Install as per manufacturer's recommendations and to suit maintenance requirements.
- .2 Install on the inlet of all pumps.

3.4 Make-Up Water Meter

- .1 Install meter on make-up water line to hydronic boiler system. Install as per schematic on drawings.

3.5 Magnetic Flow Meter

- .1 Install flow meter on the heating water return main in the boiler room. The sensor shall be mounted in an accessible location in the boiler room at a maximum of 5' (1.5m) above finished floor.
- .2 Install transmitter on wall in boiler room. The transmitter shall be mounted in an accessible location in the boiler room at a maximum of 5' (1.5m) above finished floor.
- .3 Transmitter power wiring is by Electrical Division.
- .4 BAS interface wiring at the transmitter is by Controls Contractor.
- .5 All other wiring is the responsibility of this Section.
- .6 Install communication 'WHIP', contained in conduit, to connect the wall mounted transmitter and flowtube sensor.
- .7 Obtain the services of a manufacturer's representative to test (verify) electronically that the meter is in calibration and in proper operating condition and submit a report stating same. Verification shall be done after completion of installation and before placement into service.

END OF SECTION

PART 1 - GENERAL

1.1 Standards

- .1 Construct pressure tanks to ASME Code for Unfired Pressure Vessels.
- .2 Comply with Provincial Government Regulations.

1.2 Submittals

- .1 Submit with shop drawings for tanks and installation instructions.

1.3 Inspections

- .1 Obtain inspection certificates for pressure vessels from Provincial Authorities as required.

1.4 Acceptable Manufacturers:

- .1 Bell & Gossett
- .2 Amtrol
- .3 Expansflex
- .4 Watts
- .5 Armstrong

PART 2 - PRODUCTS

2.1 Hydronic Expansion Tank – Diaphragm

- .1 Construction: Welded steel, tested and stamped to ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 125 psi (860 kPa), with flexible butyl diaphragm sealed into tank , and steel support stand.
- .2 Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 11 psi (80kPa).
- .3 Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
 - .1 Size: As scheduled.

PART 3 - EXECUTION

3.1 General

- .1 Mount tanks on 10mm (4") thick concrete housekeeping pads.

3.2 Hydronic Expansion Tank

- .1 Provide relief valves on expansion tanks.
- .2 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.
- .3 Pipe relief valve outlet to nearest floor drain for water systems.
- .4 Use saddles for horizontal mount.
- .5 Follow manufacturer's recommendations for tank charging and commissioning. Submit report on final pressure.

END OF SECTION

1 General

1.1 Submittals

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this section except for pipe and fittings.
- .2 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 refrigeration equipment manufacturers prior to being submitted to the Consultant for review.

1.2 Closeout Submittals

- .1 Submit letters from equipment suppliers certifying proper installation and start-up of piping systems and equipment as specified in Part 3 of this section.

1.3 Quality Assurance

- .1 Refrigerant piping systems are to be in accordance with CSA B52, Mechanical Refrigeration Code, and any applicable local Codes and Regulations.
- .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 Refrigerant piping and direct expansion refrigeration equipment must be installed by or under direct on site supervision of a licensed journeyman refrigeration mechanic.

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 refrigerant involved, factory cleaned and capped, and with sizes and lengths as required.

2.3 General Re: Valves and Piping Specialties

- .1 Refrigerant valves and piping specialties specified below are to factory cleaned, degreased, and supplied to site with capped ends.

2.4 Shut-Off Valves

- .1 Ball Valves
 - .1 ¼ 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, 2 O-ring stem

seals, a gasketed seal cap, a flow direction arrow cast into body, a ball position indicator on stem, and extended copper tube connections to permit brazing the valve into line without disassembling valve.

2 Manufacturers:

- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood

.2 Diaphragm Valves

- .1 Forged brass, frost-proof, Type 1 Series, CS for a 3445 kPa (500 psi) working pressure entering diaphragm chamber, one phosphor extended copper tube brazing connections. A certified packless diaphragm valves, each suitable and complete with an O-ring to prevent moisture from bronze and 2 stainless steel diaphragms, nominal " to 5/8") diameter, globe type for valves 22 mm ded tubing for brazing connections, and as follows: with a machined brass gasketed body, phosphor bronze body, forged brass cap, phosphor bronze g seal.

.2 Manufacturers:

- .1 Mueller Industries Inc.;
- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood

2.5 Check Valves

- .1 Straight through type for valves 6.4 mm to 16 mm ($\frac{1}{4}$ (7/8") diameter and larger, each complete with exten

- .1 straight through type check valves complete bronze spring, and neoprene seat;

- .2 globe type check valves complete with a cas spring, Teflon seat disc, and neoprene O-rin

.2 Manufacturers:

- .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
 - .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve
 - .3 Superior Refrigeration Products/Sherwood.

2.7 Pressure Vessel Relief Valves

- .1 Factory set pressure relief valves, straight through or angle type as required, each constructed in accordance with requirements of ANSI 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 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.8 Refrigerant Liquid Moisture Indicators

- .1 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 system is fully charged with refrigerant and remains blank when there is a restriction or shortage of refrigerant in liquid line, a moisture indicator which changes colour from blue to pink when moisture is present in system, a plastic dust cover, and extended copper tube brazing connections.
- .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.9 Liquid Line Filter-Drier

- .1 Mueller Industries Inc. "Drymaster" 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 Manufacturers:
 - .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 Manufacturers:

- .1 Senior Flexonics Canada;
- .2 The Metraflex Co.

2.11 Thermostatic Expansion Valves

- .1 Factory tested, balanced port design thermostatic expansion valves, with exact selection to suit the application and refrigerant used, each complete within a replaceable stainless-steel diaphragm and welded element construction thermostatic element charged with hydraulic fluid, and removable inlet strainer.
- .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

3 Execution

3.1 Demolition

- .1 Perform required refrigerant piping system demolition work. Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

3.2 Installation of Refrigerant Piping, Valves and Specialties

- .1 Provide 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.
- .2 Make refrigerant piping joints using a light coat of approved brazing flux applied to both pipe and fitting. Do not use acid flux. During brazing process, ensure pipe and fittings are kept full of nitrogen or carbon dioxide to prevent scale formation inside pipe and fitting.
- .3 Where shown or specified, use soft copper refrigerant piping line sets.
- .4 Provide shut-off valves to isolate each piece of equipment if shut-off valves are not supplied integral with equipment. Provide ball or diaphragm type shut-off valves inside building. Provide diaphragm shut-off valves outside building.
- .5 Provide a refrigerant charging valve for each system if such a valve is not supplied integral with equipment.
- .6 Provide refrigerant piping accessories shown and/or required and install in accordance with manufacturer's recommendations.
- .7 Provide required refrigerant.
- .8 Provide flexible connections at piping connections to roof mounted condensing units. Install in accordance with manufacturer's instructions.
- .9 Provide expansion valves where shown and/or required, each matched to coil and installed in accordance with manufacturer's instructions.

End of Section

1 General

1.1 Submittals

- .1 Submit shop drawings/product data sheets for all water treatment chemical feed equipment and associated hardware.
- .2 Submit product literature sheets for all chemicals, as well as WHMIS Material Safety Data Sheets for all chemicals.

1.2 Closeout Submittals

- .1 Submit water treatment manufacturer/supplier certification letters as specified in Part 3 of this section.
- .2 Training attendance records.

1.3 Maintenance Material Submittals

- .1 Submit water treatment test sets and spare chemicals as specified below and in Part 3 of this section.
- .2 Supply water softener salt sufficient for 2 months of normal softener operation and store salt on-site where directed by Owner.

2 Products

2.1 Characteristics of Chemicals and Spare Chemicals

- .1 Chemicals specified in this section are to be non-toxic when released to atmosphere, non-corrosive and non-staining if a leak occurs, and compatible with all system components.
- .2 Chemicals must be approved by governing authorities for release into Municipal sewer system.
- .3 For each treatment system for which chemicals are supplied, supply and hand to Owner, at Substantial Performance of the Work, spare chemical in original containers/packaging sufficient for 2 months of treatment system operation.

2.2 Manufacturers/Suppliers of Chemicals and Feed Equipment

- .1 Manufacturers:
 - .1 Ashland Hercules Water Technologies;
 - .2 Klenzoid Inc.;
 - .3 Magnus Canada;
 - .4 Chem-Aqua Canada.

2.3 [Existing Treatment Systems]

- .1 Owner has a contract with a treatment chemical supplier to maintain proper levels of chemical in building systems. New chemicals and/or treatment delivery hardware are to be supplied by this supplier. Obtain supplier's name during bidding process and obtain required pricing information.

2.4 Piping System Flushing and Cleaning Chemical

- .1 Liquid form alkaline type cleaner consisting of a concentrated blend of highly active penetrating agents and detergents with a 12.5 pH and specifically formulated to remove oil, mill scale and oxides from piping and equipment.

2.5 Closed Heat Transfer System Treatment

- .1 Chemicals, chemical feed equipment, and test equipment to control corrosion in closed heat transfer circulating systems as indicated on drawings and as specified below.
- .2 Enamelled steel or cast iron by-pass feeders sized as shown, 2060 kPa (300 psi) rated and complete with 20 mm (¾") diameter NPT pipe connection tappings, and a screw-on cast iron cap with "Buna N" "O" ring seal.
- .3 By-pass filter and flow indicator assembly equal to a Shelco Inc. FOS78, 1725 kPa (250 psi) rated replaceable cartridge filter assembly with a stainless steel housing and 20 mm (¾") diameter piping connections, sized for approximately 5% of rated circulating pump flow and complete with a minimum of 6, 20 micron filter cartridges, and a sight flow indicator equal to an Anderson Midwest Model 350SS with 20 mm (¾") diameter piping connections.
- .4 Piping tee mounting coupon holders, each complete with 25 mm (1") diameter NPT plugs with a minimum of one coupon for copper and one coupon for steel.
- .5 Chromate free, nitrite/borate type corrosion inhibitor suitable for use with both ferrous and non-ferrous metals.
- .6 Test kit for measuring inhibitor level.

2.6 Water Softeners

- .1 Package type, automatic, water conserving counterflow design water softener assembly to remove hardness to not more than 0.3 grains per gallon as determined by an ASTM standard soap test method, sized for a continuous flow rate of system make-up requirements at maximum output, and complete with:
 - .1 2 fibreglass reinforced plastic vessels, each sized for 100% of make-up requirements and complete with a moulded polypropylene structural base;
 - .2 controller for both automatic and manual regeneration, with electronic automatic regeneration based on adjustable totalized quantity of softened feed water, and designed to prevent simultaneous regenerations and permit time adjustment for backwash, brine and rinse steps;
 - .3 full charge of cation exchange resin which has a capacity of 68.8 kg/m³ (4.3 lb/ft³) of resin at a regeneration salt dosage level of 240 kg/m³ (15 lb/ft³) of resin;
 - .4 high density brine tank, sized to contain amount of salt required for 10 regenerations and complete with required PVC valves and tubing;
 - .5 softener inlet water meter, calibrated in m³;
 - .6 softener salt required for initial brine tank fill and system start-up, and bags of salt as required for 2 months of system operation;
 - .7 test kit for conducting a soap hardness test;
 - .8 factory secured seismic restraint connection hardware.

2.7 Water Treatment Testing Counters

- .1 Factory made, 1.8 m (6') long, 915 mm (36") high, 600 mm (24") deep commercial grade counter assembly with toe space, complete with:
 - .1 at one end, a 508 mm x 520 mm x 175 mm (20" x 20-½" x 7") type 316 stainless steel sink equal to a AMI #1017-C,

complete with 3-hole punched ledgeback, crumb cup strainer, and a drain fitting with 40 mm (2-½") dia. tailpiece;

.2 supply fitting equal to a Zurn #Z-831B4-Ict-25 with vandal-proof aerator and 100 mm (4") long blade handles;

.3 acid-resistant counter surface with minimum 250 mm (10") high splashback;

.4 set of double doors under sink;

.5 set of 4 drawers at end opposite sink;

.6 cupboard with 3 adjustable shelves adjacent to drawers;

.7 all required hardware, including concealed hinges, drawer slides with stops, and door pulls;

.8 acid-resisting white enamel finish on all wooden surfaces.

3 Execution

3.1 Piping System Flushing and Cleaning

.1 After new heat transfer system piping has been installed and leakage testing has been satisfactorily completed, but before mechanical equipment start-up and performance tests, flush and chemically clean piping systems.

.2 Provide required temporary piping connections, including bypass piping to isolate dirt sensitive mechanical plant equipment. Remove instrumentation such as flow meters and switches, orifice plates, meter valves and similar devices and plug pipe openings. Reinstall when flushing and cleaning work has been certified complete by chemical manufacturer/installer. Ensure control valves are operational and fully open during flushing and cleaning.

.3 Prior to chemical cleaning, flush piping, including dead ends, with water to remove loose solids. Clean all strainers. Replace chemical feeder line filters as required. Flush and drain until water runs clear.

.4 When flushing with water is complete, fill systems with fresh clean water. Meter amount of water required to fill each system or otherwise calculate system capacity. Ensure all air is vented from systems. Add cleaning chemical as instructed by chemical manufacturer and circulate solution for a period of time and at a temperature as required to produce a clean piping system. Conduct daily pH, conductivity, and total iron tests in accordance with chemical supplier's instructions.

.5 After chemical cleaning when test results indicate a clean system, drain solution from piping, refill with clean water and circulate water for a minimum of 24 hours to flush out remaining chemical solution, then drain water from piping using all drain points and again clean all system strainers and replace filters. Arrange for chemical supplier to check each system after flushing and cleaning is complete and to certify in writing that flushing and cleaning procedures have been properly performed. Submit a copy of the certification letter. Fill systems.

3.2 Installation of Closed Heat Transfer System Treatment

.1 After flushing and cleaning procedures have been certified complete, provide a by-pass chemical feeder, a cartridge filter assembly, and corrosion test coupons for each closed heat transfer system. Install in accordance with requirements of drawing details.

.2 Supply and feed into each system sufficient chemical to charge system to proper concentrations of chemical and maintain proper levels in system until Substantial Performance of the Work.

3.3 Boiler Boil-Out and Cleaning

.1 When boiler installation is complete, inspect each boiler and remove all visible debris, rust, scale, and oil, then thoroughly

flush each boiler with clean water. Provide required temporary piping connections.

.2 When flushing is complete boil-out each boiler with a chemical solution approved by boiler manufacturer to remove remaining grease, oil, and dirt. Operate each boiler at 50% of normal operating pressure for a minimum of 48 hours or until all contaminants are removed, then again flush each boiler with fresh water until all traces of chemical solution are removed.

.3 When boilers are clean and have been flushed, immediately fill each boiler with water which is chemically treated as specified in this section.

3.4 Installation of Water Softener

- .1 Provide a package type water softener assembly and secure in place on a concrete housekeeping pad.
- .2 Brace and secure assembly in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Systems.
- .3 Install equipment and components supplied loose with softener in accordance with softener manufacturer's instructions. Provide required valved piping, including drain piping terminated at a funnel floor drain combination.
- .4 Install initial charge of softener salt. Hand spare salt and soap test kit to Owner at site and store where directed.

3.8 Manufacturer's Certification, Start-Up, and Training

- .1 For all water treatment equipment include for on-site certification, start-up supervision, and system training by treatment chemical manufacturer's representative as follows:
- .2 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical;
- .3 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical;
- .4 Include for 4 hours of on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

End of Section

1. GENERAL

1.1 SUMMARY

- A. This section includes Energy Wheel Air-to-Air Energy Recovery Ventilators for indoor installation.

1.2 SUBMITTALS

- A. Product Data: For each type or model include the following:
1. Complete fan performance curves for both the supply air and exhaust air, with system operating conditions indicated, as tested in an AMCA Certified Chamber.
 2. Energy wheel performance data for both summer and winter operation.
 3. Motor ratings, electrical characteristics, motor, and fan accessories.
 4. Energy wheel performance data in accordance with AHRI Standard 1060-2023 for each model. Data shall include Psychrometric Conditions, Effectiveness, Exhaust Air Transfer Ratio (EATR), Outdoor Air Correction Factor (OACF), pressure drop of the device, Net Supply Airflow, Leaving Exhaust Airflow Psychrometric Conditions, and Enthalpy Recovery Ratio.
 5. Material types and gauges of all component pieces and assemblies.
 6. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
 7. Estimated gross weight of each installed unit.
 8. Installation, Operating and Maintenance manual (IOM) for each model.
 9. Microprocessor Controller (DDC) specifications to include available options and operating protocols. Include complete data on all factory-supplied input devices.
 10. Sound performance data for Supply Air and Exhaust Air as tested on an AMCA Certified chamber.

1.3 QUALITY ASSURANCE

- A. Product Options: Drawings must indicate size, profiles and dimensional requirements of Energy Recovery Units and are to be based on the specific system indicated. Refer to Division 1 Section "Product Requirements".
- B. End of line test with full report available upon request.
- C. Certifications:
1. Entire unit shall be ETL Certified per U.L. 60335-2-40 and bear an ETL sticker.
 2. Energy wheel performance shall be AHRI Certified per Standard 1060.

1.4 COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.
- B. Coordinate sequencing of construction of associated HVAC, electrical supply [roofing contractor].

1.5 EXTRA MATERIALS

-
- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: [(Insert quantity) set(s) of [MERV 8] or [MERV 13] disposable filters for each unit].
 - 2. One spare energy wheel belt.

2. PRODUCTS

2.1. MANUFACTURERS

- .1 The following manufacturers are approved for use:
 - 1. Base bid: Greenheck
 - 2. Alternatives: Carrier, Lennox, Lifebreath

2.2. MANUFACTURED UNITS

Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, energy wheel, motorized intake damper, motorized exhaust damper, sensors, frost control, economizer control, electric preheater, filter assembly for intake and exhaust air, supply air blower assembly, exhaust air blower assembly, electronically commutated motors (ECM) and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

2.3. CABINET

- A. Materials: Formed double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - 1. Unit's exterior shall be supplied from the manufacturer using G60 galvalume steel with proprietary pre-painted material in the following finish color; Concrete Gray-RAL 70023. This has been subjected to a salt spray test per ASTM-B117 and evaluated using ASTM-D714 and ASTM-D610 showing no observable signs of rust or blistering until reaching 2,500 hours.
 - 2. Internal assemblies: 24-gauge, pre-painted galvalume (G60) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
- B. Access doors shall be captured access. This access should allow for sliding of access doors and prevent doors from falling or needing to be removed for regular maintenance. Doors should be fully removable if desired.
- C. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - a. Materials: Rigid urethane injected foam. Foam board not acceptable.
 - .1 Thickness: 1 inch (25 mm)
 - .2 Thermal Resistance: R8
 - .3 Meets UL94HF-1 flame requirements
 - .4 Location and application: Full coverage of entire exterior to include walls, roof of unit, unit base and doors
- D. Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel

as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned drive belt. The wheel media shall be a polymer film matrix in a stainless-steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and shall be designed and constructed to permit cleaning and servicing. The energy wheel is to have a five-year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.

- E. Control panel/connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections
- F. Frost control: Timed Exhaust. Timed exhaust shall be provided for frost control of the energy wheel. Control system shall include an outdoor air thermostat and pressure sensor on the wheel assembly to initiate frost control sequence.

2.4. BLOWER

- A. Blower section construction, Supply Air and Exhaust Air: Direct drive motor and blower shall be assembled onto a 14-gauge galvanized steel platform.
- B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
- C. Fan: Direct drive, backwards curved, airfoil plenum fan with [aluminum] wheel statically and dynamically balanced. Prop or belt-drive fan not acceptable due to low static capabilities
- D. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

2.5. MOTORS

- A. General: Blower motors greater than 1/2 horsepower shall be "NEMA Premium™" unless otherwise indicated. Minimum compliance with EPC minimum energy-efficiency standards for single speed ODP and TEFC enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase, and enclosure. Comply with the requirements in Division 23 05 13, matched with fan load.
- B. Motors shall be 60 cycle, 1 phase 208 volt, The designation "NEMA Premium™" applies to electric motors with efficiencies that are "better than EPC". ECM motors are considered premium equivalent. The terms "high efficiency" or "premium efficiency" have no industry definitions.

2.6. UNIT CONTROLS

- A. The unit shall be constructed so that it can be controlled by a factory-supplied controller, or it can be monitored and controlled by a Building Management System (BMS). This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.

-
- B. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status, operating settings, and alarm conditions. DDC controllers shall have a built-in keypad to permit operator to access read-out screens and change settings without the use of ancillary equipment, devices, or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable]. Note: some manufacturers are known to incorporate DDC controllers that require the use of separately purchased handheld hardware or a PC and/or software to view or change settings. Owner-specified ventilating conditions can be input by means of pushbuttons.
 - A. Operating protocol: The microprocessor shall be factory-programmed for [BACnet MSTP] [BACnet IP] [Modbus RTU] [Modbus IP] for monitoring of the unit's status]. Specify protocol.
 - C. Supply fan shall be configured for CO2 sensor
 - D. Exhaust fan shall be configured for building pressure
 - E. Remote Display: Contractor shall provide and install a remote display that functions as a remote indicator of owner-selected operating parameters and also permits remote inputting of new operating parameters. Each remote display shall have a large LCD user interface screen similar in form and function to the screen on the DDC. Installed location of remote display shall be as indicated on the plans
 - F. A web user-interface (web UI) must be available for the manufacturer installed controls. The interface can be accessed via a web browser when an Ethernet cable is connected to the building network or to a laptop plugged in directly to the controller. Web UI must have the following features available which allow simple access to the unit, improved startup commissioning and provide quick troubleshooting capabilities:
 - i. Graphical overview screen for easy access to current conditions and set point changes
 - ii. All sensor values, set point and control outputs recorded each minute with 1 week of history stored on the controller for simple troubleshooting
 - iii. Refrigeration details screen with compressor status, temperature and pressure readings
 - iv. Access to current alarms and alarm history
 - v. Service override capabilities to manually change I/O and verify proper operation of the unit
 - G. Sensors
 - A. Dirty Filter Sensors
 - B. CO2 Sensor
 - C. Temperature Sensors- OAI, EAD, RAI, OAD Note: OAI and OAD are standard with microprocessors.
 - D. Relative Humidity Sensors – OAH, RAH

2.7 FILTERS

MERV8 disposable pleated filters shall be provided in the intake & exhaust air stream

3. EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with the manufacturer's Installation & Maintenance instructions.

3.2 ENVIRONMENTAL REQUIREMENTS

- .1 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.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 REFERENCES

- .1 ASHRAE HANDBOOK, HVAC SYSTEMS & EQUIPMENT, Duct Construction Recommendations
- .2 Sheet Metal And Air Conditioning Contractors' National Association (SMACNA)
 - .1 HVAC Duct Construction Standards - Metal and Flexible
 - .2 HVAC Duct Systems Design
 - .3 Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
 - .4 Accepted Industry Practice for Industrial Duct Design
 - .5 HVAC Systems - Testing, Adjusting and Balancing
 - .6 Round Industrial Duct Construction Standards
 - .7 Rectangular Industrial Duct Construction Standards
 - .8 HVAC Air Duct Leakage Test Manual.
 - .9 Guide for Steel Stack Construction
- .3 National Fire Protection Association (NFPA)
 - .1 80 Standard for Fire Doors and Windows
 - .2 90A Standard for Installation of AC and Ventilation Systems
 - .3 90B Standard for Installation of Warm Air Heating and AC Systems
 - .4 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
 - .5 255 Building Materials, Test of Burning Characteristics (same as ASTM E84)

1.3 PERFORMANCE REQUIREMENTS

- .1 No variation of duct configuration or sizes permitted except by written permission.
- .2 Size round ducts installed in place of rectangular ducts to ASHRAE table of equivalent rectangular and round ducts.
- .3 Sizes indicated on drawings are clear inside dimensions and do not include for duct linings.

1.4 SUBMITTALS

- .1 Division 1: Procedures for submittals.
- .2 Product Data: Provide data for duct materials.
- .3 Shop Drawings:
 - 1. Plenums and plenum related items showing physical dimensions, joints, sealants, door construction and hardware.
 - 2. Factory fabricated ducts, fittings and joining systems.
 - 3. Firewall duct penetrations; fire and smoke dampers; louvers and access doors.
 - 4. Duct fitting particulars such as gauges, sizes, welds, reinforcements and configuration for 4" wg. (1000 kPa) pressure class and higher systems.
- .4 Submit changes or alterations in ductwork layout, with supporting calculations showing that the modified design will not increase total pressure, before work commences. Submittals for proposed changes shall be stamped for acceptance prior to commencement of work.
- .5 Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.
- .6 Material Safety Data Sheets (MSDS) for sealants, adhesives and coatings.

1.5 PROJECT RECORD DOCUMENTS

- .1 Division 1: Submittals for project closeout.
- .2 Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

- .1 Perform Work to SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .2 Perform Duct Leakage Testing to SMACNA "HVAC Air Duct Leakage Testing Manual"
- .3 Maintain one copy of document on site.
- .4 Asbestos Free: Insulating and sealing materials must be certified to be free of asbestos.
- .5 Brazing: Certify brazing procedures, brazers, and operators in accordance with AWS B2.2 Brazing Procedures and Performance Qualifications
- .6 Welding: Certify welding procedures, welding equipment and welders in accordance with AWS D9.1 Sheet Metal Welding Code.

1.7 REGULATORY REQUIREMENTS

- .1 Ontario Building Code (OBC)
- .2 Ontario Fire Code (OFC)
- .3 Construct ductwork to NFPA 90A standards.

1.8 ENVIRONMENTAL REQUIREMENTS

- .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.

2 Products

2.1 MATERIALS

- .1 Table of Materials

APPLICATIONS	MATERIALS
Rigid HVAC ducts, casings, and fittings	ASTM A653 galvanized steel sheet, lock form quality, G90 zinc coating (0.90 oz/ ft2) to ASTM A90. Sheets free of pits, blisters, slivers, and ungalvanized spots.
Rigid HVAC ducts, casings and fittings installed underground (below slabs on grade). Rigid HVAC ducts, casings and fittings installed in swimming pools (natatorium).	PVC coated, galvanized steel sheets, lock form quality to ASTM A653 G90 zinc coating (0.90oz/ ft2 both sides) and factory applied 4-mil PVC coating Ductwork shall be UL-181, Class 1 listed.

- .2 Hanger Rod: continuously threaded, ASTM A36 galvanized steel.
- .3 Sealant: Non-hardening, water resistant, fire resistive, low VOC (VOC content not to exceed 250 g/L), compatible with mating materials; liquid used alone or with tape, or heavy mastic.
- .4 Supports: Angle iron, channels, rods and related supporting materials shall be galvanized or red oxide coated.

- .5 Fasteners: Use galvanized rivets, screws and bolts throughout, except on stainless steel ductwork, use SS fasteners.
- .6 Reinforcements: Provide galvanized steel or stainless steel reinforcement shapes and plates to match ductwork.
- .7 Tie Rods: Use galvanized steel, 1/4 inch minimum diameter fasteners for ductwork 36 inch or less in length; use 3/8 inch minimum diameter for lengths longer than 36 in.

2.2 DUCT CONSTRUCTION

- .1 Duct Construction Schedule

Duct Application	Duct Pressure	Pressure Class (in.wg.)	Seal Class	Leakage Class
Rectangular HVAC Supply from terminal unit to air outlet	Positive	2	A	6
Round HVAC Supply from terminal unit to air outlet	Positive	2	A	3
Rectangular HVAC single zone supply from AC Unit to air outlet	Positive	2	A	6
Round HVAC Single zone supply from AC Unit to air outlet	Positive	2	A	3
Rectangular HVAC Return from air outlet to AHU	Negative	2	A	6
Rectangular HVAC Return from air outlet to AHU	Negative	2	A	3
Rectangular Sanitary exhaust ductwork	Negative	2	A	6
Round Sanitary exhaust ductwork	Negative	2	A	3
Rectangular General HVAC exhaust ductwork	Negative	2	A	6
Round General HVAC exhaust ductwork	Negative	2	A	3

2.3 DUCT SEALING

- .1 Duct Sealing Requirements

SEAL CLASS	SEALING REQUIREMENTS
A	All transverse joints, longitudinal seams, and duct wall penetrations
B	All transverse joints and longitudinal seams
C	All transverse joints

2.4 DUCT LEAKAGE

- .1 Leakage Class is defined as

$$C_L = F / (P)^{0.65}$$

where: C_L = Leakage Class

F = Leakage Factor (cfm/100-ft² of duct surface)
 P = Static pressure in the duct (in.wg.)

- .2 Table

LEAKAGE FACTOR (F) CFM / 100-SQ.FT. of DUCT SURFACE

LEAK CLASS	PRESSURE CLASS (in.wg) (+ve or -ve)				
Q	1	2	4	6	10
48	48	75	118	154	214
24	24	38	59	77	107
12	12	19	30	38	54
6	6	9	15	19	27
3	3	5	7	10	13
0	0	0	0	0	0

2.5 DUCTWORK FABRICATION

- .1 All Ductwork shall be constructed to withstand 1-1/2 times fan pressure at shut-off and 2" (500 Pa) minimum.
- .2 Fabricate and support to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated in accordance with recommendations of ASHRAE and SMACNA.
- .3 Joints and reinforcements:
 1. to SMACNA and ASHRAE
 2. may be made with the Ductmate System or Nexus System. System components shall be made of standard catalogue manufacture as supplied by Ductmate Industries, Inc. or Nexus Inc.
- .4 Construct Tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centreline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fibre insulation.
- .5 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- .6 Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints: minimum 100 mm cemented slip joint, brazed or electric welded. Prime coat welded joints.
- .7 Provide standard 45-degree lateral wye takeoffs. Alternative 90-degree conical tee connections may be used only where specifically indicated.

2.6 ROUND SPIRAL LOCK SEAM DUCTWORK

- .1 Spiral ducts and elbows shall not be used for watertight exhaust systems.
- .2 Ducts and fittings shall be manufactured from minimum G90 galvanized steel meeting ASTM A527/A527M-85.
- .3 Ductwork shall be "Uni-Seal" single wall, round spiral lock-seam type duct in wall thicknesses listed below.
- .4 Fittings shall be "Uni-Form" single wall, round fittings suitable for use with "Uni-Seal" ductwork in wall thicknesses as follows:

Diameter	Duct Metal Thickness		Fitting Metal Thickness	
In.(mm)	In. (GA)	(mm)	In. (GA)	(mm)
3 (75) to 14 (356)	0.022 (26 ga.)	(0.56)	0.028 (24 ga.)	(0.70)
15 (380) to 26 (660)	0.028 (24 ga.)	(0.71)	0.034 (22 ga.)	(0.86)
27 (686) to 36 (914)	0.034 (22 ga.)	(0.86)	0.040 (20 ga.)	(1.0)
37 (939) to 50 (1270)	0.040 (20 ga.)	(1.0)	0.052 (18 ga.)	(1.32)
52 (1321) to 60 (1524)	0.052 (18 ga.)	(1.32)	0.064 (16 ga.)	(1.62)
- .5 Acceptable Manufacturer: "Uni-Seal" spiral lock-seam duct and "Uni-Form" fittings as manufactured by United Sheet Metal. Other manufacturers refer to Section 15010.2.3

2.7 FLEXIBLE DUCTWORK

- .1 Flexible ducts shall be factory fabricated to CAN/ULC S110, factory fabricated assembly with a laminated inner liner of aluminum foil, fiberglass and polyester, a galvanized steel helix coil formed to the inner liner, a fiberglass insulation blanket, and a polyethylene outer jacket. Flexible duct shall have a flame resistant rating of 25 or less and a smoke developed rating of 50 or less

Pressure Rating	Low & Medium	High Pressure
Max. positive pressure	6"wg (3 kPa)	12"wg (6 kPa)
Max. negative pressure	4"wg (2 kPa)	5"wg (2.5 kPa)
Maximum velocity	4000 fpm (20m/s)	5500 fpm (28m/s)
Permeance	0.1 perm	0.1 perm
Operating temperature	-20 to 250 deg. F	-20 to 250 deg. F
Max. thermal conductance	0.23 BTU/Hr-F°	0.23 BTU/Hr-F°
Listed & Labelled	Class 0 /Class 1	Class 0 /Class 1
Flex master Type	5	3

- .2 Lab Exhaust Systems: Ductwork to be a factory fabricated assembly of neoprene-coated polyester with galvanized steel helix reinforcement. Flexible duct shall be rated for a minimum of 6.0" w.g. positive pressure, 4.0" w.g. negative pressure, 5500 FPM velocity, -65 to 250 degrees F. Flexible duct shall have a flame resistant rating of 25 or less and a smoke developed rating of 50 or less. Uni-flex Model U-LOK 200.
- .3 Accessories: conical spin-in collars with butterfly volume dampers for connections to ductwork, round rigid galvanized steel fittings fabricated to SMACNA Standards and ASHRAE recommendations, bridge and gear clamps.
- .4 Acceptable Manufacturers:
- .1 Flexmaster
- .2 Others refer to Section 15010.2.3.
- 26 (650) to 32 (800) 20 0.040 (1.006)
- .5 Acceptable Manufacturers:
- .1 Uni-Coat as manufactured by United Sheet Metal.
- .2 Other manufacturers refer to Section 15010.2.3.

2.8 DESIGN REQUIREMENTS

Ductwork System:

- .1 Primary supply air ductwork (between discharge side of fan and terminal boxes) shall be medium pressure class as a minimum.
- .2 Secondary supply air ductwork (eg downstream of terminal boxes) shall be low pressure class as a minimum.
- .3 Use round or oval ducts instead of rectangular ducts to reduce leakage and drum effect from vibration.
- .4 Ductwork shall be as direct as possible to minimize the number of elbows, abrupt contractions and expansions and transitions.
- .5 Long radius elbows and 45 degree lateral take-offs should be used wherever possible.
- .6 Provide sufficient straight duct run before diffusers to minimize turbulence induced noise.

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- .7 Flexible ductwork may be used but shall be limited to connections between duct branches and diffusers or VAV terminal units and shall be limited to 6' long. Flexible ductwork shall be installed fully extended with bend radius greater than the duct diameter to avoid kinking.
 - .8 Ductwork outside the building should be avoided to minimize heat gain to or heat loss from the ductwork.
 - .9 Duct-mounted access doors shall be provided in ductwork wherever there are manual dampers, fire dampers, turning vanes, coils to allow inspection.
 - .10 All exhaust ductwork within the building shall be under negative pressure.
- .2 Ductwork Protection and Cleaning:
- .1 Refer to Region Technical Standard Section 01 45 16.23 – *Indoor Air Quality Management*.
 - .2 During manufacture and storage, cap off ends of ducts until ready for installation.
 - .3 During installation cap off ends of unfinished ducts while plastering, drywall and other operations are in progress.
 - .4 Cover open ends or registers of exhaust/return ducts with 1" thick filter media secured with tape. Filter media to remain until all dust producing operations are completed.
 - .5 If after inspection by the Project Architect and/or Region Project Manager the ductwork systems is deemed to be unacceptable, the Contractor shall prior to operation or test and balance, clean systems and equipment including but not limited to ductwork (supply/return/exhaust), air handling equipment, plenums, terminal units, fans, dampers, grilles/registers/diffusers with high power vacuum machines. Cleaning shall be performed in accordance with National Duct Cleaners Association (NADCA) standards, and by agent specializing in this field of work, and a member in good standing with NADCA. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Submit report, verified by TAB Agent, identifying the extent of duct system cleaning and certifying that NADCA standards have been met.
 - .6 Provide adequate access into ductwork for cleaning purposes.
- .3 Ductwork Sealing and Leak Testing:
- .1 Ductwork seams and joints shall be sealed for a Seal Class B including all traverse joints, longitudinal seams, and connections. Connections include spin-ins, taps, branch connections, access doors, and connections to equipment.
 - .2 Ductwork shall be leak tested at the rated pressure in accordance with SMACNA HVAC Duct Leakage Test Manual. A leak test report shall be provided to the Region.
 - .3 Duct sealing and leak testing shall be conducted before ductwork is insulated or concealed by drywall or T bar ceiling to allow for re-sealing or repairing duct sections.
 - .4 The leakage shall not exceed the allowable cfm/100ft² of duct area for the seal and leakage class apportioned to each section tested.
 - .5 **Ductwork leak testing shall be witnessed by the Commissioning Authority or a Regional Municipality of York representative.**
- .4 Duct Insulation:
- .1 All supply air ductwork shall be insulated.
 - .2 All return air ductwork located above the ceiling and below the building roof shall be insulated.

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- .3 All outdoor supply or return ductwork shall be insulated.
 - .4 Insulate the first 3m of all exhaust ductwork from an exterior wall.
 - .5 All exhaust or relief air ductwork between motor operated dampers and building exterior penetration point shall be insulated.
 - .5 Air Plenums:
 - .1 Return air plenums that are formed by exterior walls, and roof slabs shall be sealed air-tight to prevent untreated outdoor air from being drawn into the return air stream.
 - .6 Air Terminal Units:
 - .1 Variable-Air-Volume (VAV) terminals shall be certified under ARI 880 Standard for Air Terminals.
 - .2 VAV terminals shall be pressure-independent type and capable of operating satisfactorily throughout their range from minimum to maximum air flow.
 - .3 VAV terminals to be volume control calibrated to identify air volume in increments of percent of maximum air flow.
 - .4 Damper controls to be accessible from outside the unit. Damper position to be visible from outside the unit.
 - .5 Re-heat coils shall have access for cleaning.
 - .6 VAV terminal units shall have BACnet controls.
 - .7 Fan-powered VAV terminals located in the ceiling should be avoided to reduce maintenance, and noise concerns.
 - .8 Hot water re-heat coils may be used in the VAV boxes particularly for perimeter zones and if required for zone temperature control. If used in conjunction with hot water perimeter radiators, the radiators should be the first stage of heating and the re-heat coils the second stage.

3 Execution

3.1 INSTALLATION

- .1 Install and seal ducts to SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- .2 Install ductwork parallel to building lines.
- .3 Support all ductwork from structural members. Where structural bearings do not exist, suspend strapping or hangers from steel channels or angles. Provide supplementary structural members. Do not suspend from metal deck.
- .4 Do not break continuity of insulation vapour barrier by hangers or rods.
- .5 Hangers shall be steel angles with supporting rods, locking nuts and washers to following table;
[Except for Fire Rated Ventilation Ductwork or Fire Rated Kitchen Exhaust Grease Duct which shall comply with ULC Listing and manufacturers instructions]

Duct Sizes	Angle Size	Rod Size	Spacing
up to 30"	1" x 1" x 1/8"	1/4"	10 feet
31" to 42"	1-1/2"x1-1/2"x1/8"	1/4"	10 feet
43" to 60"	1-1/2"x1-1/2"x1/8"	3/8"	10 feet
61" to 84"	2" x 2" x 1/8"	3/8"	8
feet Duct Sizes	Angle Size	Rod Size	
	Spacing Up to 750 mm	25 x 25 x 3 mm	6
mm	3 metres		
775 to 1050 mm	40 x 40 x 3 mm	6 mm	3 metres

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- | | | | | |
|--|-----------------|----------------|-------|------------|
| | 1075 to 1500 mm | 40 x 40 x 3 mm | 10 mm | 3 metres |
| | 1525 to 2100 mm | 50 x 50 x 3 mm | 10 mm | 2.5 metres |
- .6 Anchor all risers at bottom and support from building structure at each floor level.
 - .7 Vertical ducts passing through floors shall be supported on angles secured to duct bearing on the floor.
 - .8 Where ducts pass through walls, floors, openings required to have a fire resistance rating the opening in the construction around the duct shall be filled with an approved fire stop material as per NFPA 90A and fire damper shall also be installed with access doors as per the code.
 - .9 Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
 - .10 Provide openings in duct work where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
 - .11 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
 - .12 Use crimp joints with or without bead for joining round duct sizes 8" (200 mm) and smaller with crimp in direction of air flow.
 - .13 Use double nuts and lock washers on threaded rod supports.
 - .14 Connect terminal units to supply ducts directly or with 12" (300 mm) maximum length of flexible duct. Do not use flexible duct to change direction.
 - .15 Connect diffusers or light troffer boots to low pressure ducts directly or with 60" (1.5 m) maximum length of flexible duct held in place with strap or clamp.
 - .16 Connect flexible ducts to metal ducts with adhesive and metal or nylon straps.
 - .17 Ground across flexible connector with No. 2/0 braided copper strap.
 - .18 Set plenum doors 6" to 12" (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.
 - .19 During construction provide temporary closures of metal or taped polyethylene on open duct work to prevent construction dust from entering duct work system.
 - .20 Install HTL ductwork between duct silencer and mechanical room wall.
 - .21 Balancing dampers shall be installed on branches as per locations shown on the drawings and as per the requirements of NEBB and AABC listing/measuring standards.
 - .22 Perform duct leakage testing for all ductwork installed under this contract.

3.10 FLEXIBLE DUCTWORK

- .1 Flexible ductwork may be installed for final connections to air outlets provided that not more than 5 ft. (1.5 m) in length is used for each connection, and where specifically indicated on drawings.
- .2 All fittings used with flexible ductwork shall be rigid round duct.
- .3 Use pre-insulated flexible ductwork where application is to be insulated.

3.11 DUCT LEAKAGE TESTING

- .1 Ductwork shall be leak tested in accordance with the SMACNA "HVAC Air Duct Leakage Test Manual". The maximum permitted duct leakage shall be determined by multiplying the leakage factor from paragraph 2.4 above by the surface area of the ductwork in the test zone.
- .2 Ductwork that exceeds the maximum permitted leakage shall be re-sealed and re-tested.
- .3 Duct leakage test shall be witnessed and certified by the Systems Verification Agency of section 15020.
- .4 Record and submit three (3) copies of test results to the Consultant for review prior to application of duct insulation or concealment of ductwork.

End of Section

1 General

1.1 Submittals

- .1 Submit shop drawings/product data sheets for fans and accessories. Include following:
 - .1 Certified fan performance curves at specified operating point with flow, static pressure and HP clearly plotted;
 - .2 Certified sound power data that conforms to specified levels;
 - .3 Product data sheets for all accessories.
 - .4 Product data sheets for fan motors.

1.2 Closeout Submittals

- .1 Submit with delivery of each unit a copy of the factory inspection report and include a copy of each report with O&M Manual project close-out data.
- .2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.
- .3 Supply reviewed copies of fan/curb assembly shop drawings or product data to trade who will cut roof openings for fans, and ensure openings are properly located.
- .4 Supply reviewed copies of fan assembly shop drawings or product data to trade who will form/prepare wall openings for fans, and ensure openings are properly located.
- .5 Submit a signed copy of destratification fan manufacturer's 5 year extended parts and labour warranty.
- .6 Submit a signed copy of ceiling mounted fan manufacturers extended 3 year warranty.
- .7 Training attendance records.

1.3 Quality Assurance

- .1 Fan manufacturers, as applicable, are to be current members of the Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:
 - .1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
 - .2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
 - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;
 - .4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;
 - .5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.

2 Products

2.1 Roof Mounted Exhaust Fans

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- .1 Centrifugal, ULC listed, factory run tested roof mounted exhaust fans in accordance with drawing schedule.
 - .2 Spun aluminium housing with deep venturi inlet, aluminium curb cap with continuously welded corners, pre-punched mounting holes, galvanized steel or aluminium bird screen, and EMT conduit chase to the motor compartment.
 - .3 Centrifugal, non-overloading aluminum wheel with backward inclined blades matched to inlet venturi, statically and dynamically balanced as an assembly.
 - .4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and one-piece grease lubricated pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours at maximum catalogue operating speed and equipped with a lubrication fitting, and a heavy-gauge galvanized steel adjustable V-belt drive with guard conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.
 - .5 Motors are to conform to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, mounted on vibration isolation in a compartment outside of the airstream, and factory pre-wired to a NEMA 4 disconnect switch.
 - .6 Prefabricated, minimum 300 mm (12") high heavy-duty aluminum roof mounting curb with factory installed wood nailer, 40 mm (1-½") thick insulation, continuously welded seams, and damper tray.
 - .7 For fans as scheduled, factory supplied accessories as follows:
 - .1 gravity backdraft damper with #20 gauge galvanized steel frame and #26 gauge aluminum blades with felt edge blade seals;
 - .2 non-corrosive motorized damper with linkage, end switch, and motor with voltage to match fan motor;
 - .3 continuous non-corrosive piano type curb hinge to permit access to fan, damper and connecting duct, complete with retaining chain and a security hasp to prevent removal of unit from curb cap and prevent building entry through connecting ductwork;
 - .4 2-speed switch and 2-speed double winding 1-phase motor in accordance with Section 20 05 00 – Common Work Results for Mechanical;
 - .5 factory secured seismic restraint connection hardware.
 - .8 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 JencoFan;
 - .5 Carnes Company Inc.

2.2 Centrifugal Inline Fans

- .1 Centrifugal, ULC listed, factory run tested rectangular inline fans in accordance with drawing schedule.
- .2 Heavy-gauge galvanized steel housing with removable side panels to permit removal of power assembly without disturbing duct connections, universal mounting brackets and hardware including spring vibration isolators to

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- accommodate horizontal or vertical mounting as required, a flanged inlet panel with inlet venturi, a flanged outlet panel, both with duct connection collars, and galvanized steel wire grid fan inlet/outlet guard(s).
- .3 non-overloading aluminium wheel with backward inclined blades with matching inlet venturi, statically and dynamically balanced as an assembly.
 - .4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and heavy-duty, self-aligning pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours and equipped with lubrication line and fitting, and an adjustable V-belt drive with guard conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.
 - .5 TEFC motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, mounted out of the airstream, complete with a cover, and factory pre-wired to a NEMA 4 disconnect switch.
 - .6 For fans as scheduled, factory supplied accessories as follows:
 - .1 for fans as scheduled, housing insulation (lining), consisting of neoprene spray coated glass fibre semi-rigid insulation meeting NFPA 90A requirements and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, permanently secured in place with no exposed edges;
 - .2 for fans as scheduled, a galvanized steel filter box with frame suitable for 25 mm (2") thick disposable panel type filters;
 - .3 factory secured seismic restraint connection hardware.
 - .7 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 JencoFan;
 - .5 Carnes Company Inc.

2.3 Centrifugal Wall Mounted

- .1 Fan shall be a spun aluminum, wall mounted, direct driven, horizontal centrifugal exhaust ventilator.
- .2 Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.
- .3 Construction: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The spun aluminum wall flange shall have pre-punched key slot holes and a mounting template with wall opening location for ease of installation. The windband shall have a rolled bead for added strength. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor shall be enclosed in a weathertight compartment, separated from the exhaust airstream. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicating design CFM and static pressure.
- .4 Unit shall be shipped in ISTA certified transit tested packaging.
- .5 Wheel: Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance

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- Quality and Vibration Levels for Fans.
- .6 Motor shall be an electronically commutated motor rated for continuous duty and furnished either with internally mounted potentiometer speed controller or with leads for connection to 0-10 VDC external controller.
- .7 Manufacturers:
- .1 Twin City Fan and Blower;
- .2 Loren Cook Co.;
- .3 Greenheck Fan Corp.;
- .4 JencoFan;
- .5 Carnes Company Inc.

3 Execution

3.1 Installation of Roof Mounted Exhaust Fans

- .1 Provide roof mounted exhaust fans.
- .2 Supply a roof mounting curb with each fan and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of roofing work. Secure fans in place on curbs.
- .3 Install dampers in curb damper tray and secure in place.
- .4 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .5 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.2 Installation of Centrifugal Inline Fans

- .1 Provide inline centrifugal fans.
- .2 Secure each fan in place from structure with vibration isolation, independent of connecting ductwork and in accordance with fan manufacturer's instructions.
- .3 Brace and secure each unit in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Systems.
- .4 Ensure duct connections are made using flexible connection material.
- .5 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .7 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all

components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.3 Installation of Ceiling Destratification Fans

- .1 Provide ceiling destratification fans.
- .2 Secure each fan in place at the ceiling from structure in accordance with manufacturer's instructions and drawing details. Confirm exact locations prior to roughing-in. Install safety chains and fan blade guards.
- .3 Plug each fan motor into an adjacent receptacle.
- .4 Supply a fan speed controller for fans as indicated and hand to electrical trade at site for wall mounting and connection to fan motor controllers. Confirm exact speed controller locations prior to installation, and include for identification of each speed controller.
- .5 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .7 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.4 Training

- .1 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration.

End of Section

1 General

1.01 Submittals

- .1 Submit shop drawings/product data sheets for air terminals. Include following:
 - .1 capacity and pressure drop;
 - .2 sound power data to verify conformance with specified sound power levels;
 - .3 leakage and dimensions;
 - .4 mounting details to suit locations shown, indicating methods and hardware to be used;
 - .5 control components and a control wiring schematic.
- .2 Submit with shop drawings/product data, a test report in accordance with ANSI/AMCA 210 requirements and ISO 3741, published test data on DIN (Direct Internal Noise) made by an independent testing agency for 2.5 and 6 m/s (8.2 and 19.7 ft/min) branch velocity or inlet velocity, sound power levels with a minimum inlet pressure of 0.25 kPa (0.036 psi) in accordance with ISO 3741 for the 2nd through 7th octave bands, and confirmation pressure loss through a silencer will not exceed 60% of inlet velocity pressure maximum.

1.02 Closeout Submittals

- .1 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.

1.03 Quality Assurance

- .1 Air terminals manufacturers are to be current members of Air-Conditioning, Heating and Refrigeration Institute (AHRI), and terminals are to be in accordance with requirements of following standards:
 - .1 ANSI/AHRI Standard 880, Performance Rating of Air Terminals;
 - .2 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
 - .3 International Organization of Standardization (ISO) Standard 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure-Precision Methods for Reverberation Rooms.
- .2 Equip boxes with factory secured seismic restraint connection hardware.

2 Products

2.01 Manufacturers

- .1 Price Industries Inc.;
- .2 Titus;
- .3 Nailor Industries Inc.;
- .4 Krueger Division of Air System Components Inc.

2.02 Variable Air Volume (VAV) Terminal Boxes

- .1 Single duct, controller type, pressure independent variable air volume boxes in accordance with drawing schedule, each individually field adjustable to minimum and maximum air volumes, and complete with:
 - .1 #22 gauge galvanized steel housing, sealed and gasketed, internally lined with 25 mm (1") thick glass fibre duct lining material with a neoprene coating meeting NFPA 90A and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, and complete with:
 - .1 exposed cut edges of the liner material factory coated with NFPA 90A and CAN/ULC S102 approved sealant;
 - .2 50 mm (2") long, round inlet duct connection;
 - .3 rectangular discharge opening with slip and drive cleat duct connection facilities;
 - .4 protective galvanized steel shroud for controller and damper actuator.
 - .2 air valve damper, normally open, galvanized steel blade with peripheral gasket, pivoting in self-lubricating bearings and with air leakage past a closed damper of 2% or less of rated capacity at 750 Pa (3" wc) inlet static pressure;
 - .3 air flow sensor located at box inlet, complete with gauge taps, multiple pressure sensing ports, and an averaging chamber designed to accurately average the flow across the inlet of box with an accuracy of within 5% with a 90° sheet metal elbow located directly at inlet, and amplify the sensed air flow signal;
 - .4 electronic controller/actuator factory installed, connected and tested control package including an electronic controller, electronic flow transducer, and an electronic actuator for damper, all calibrated and factory set for maximum and minimum air flow, field adjustable, and equipped with gauge taps for balancing with a standard pressure gauge;
 - .5 digital controller/actuator factory installed, connected and tested control package including a microprocessor based stand-alone digital controller capable of networking with a building automation system, personal computer, or a portable operator interface device, an electronic flow transducer, and an electronic actuator for damper, all calibrated and factory set for maximum and minimum air flow, field adjustable and equipped with gauge taps for balancing with a standard pressure gauge;
 - .6 for boxes as scheduled, AHRI performance rated and certified, CSA certified electric reheat coils in accordance with drawing schedule, each factory mounted, wired and tested and complete with:
 - .1 galvanized steel coil frame and cabinet with 20 mm (¾") thick neoprene coated glass fibre insulation meeting NFPA 90A and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102;
 - .2 hinged access door for electrical enclosure;
 - .3 low watt density coil consisting of minimum Grade 80/20 nickel-chromium wire elements insulated from frame by floating ceramic bushings;
 - .4 pre-wired safety devices and controls including:
 - .1 automatic reset primary thermal cut-out and a manual reset secondary thermal cut-out;
 - .2 differential pressure switch to shut-down coil upon sensing a no air flow condition;

- .3 electronic modulating controller compatible with building controls for proportioned pulsed AC or DC control of heater;
- .4 door interlock disconnect switch;
- .5 mercury contactors;
- .6 Class II, 24 volt AC control transformer as required.
- .7 galvanized steel attenuators, lined as per box housings, each factory supplied loose and with a length in accordance with drawing schedule;
- .8 wall mounting thermostat with thermometer and guard, supplied with boxes by box manufacturer, suitable in all respects for box it controls and control sequence, and complete with all required installation and connection accessories.
- .2 Terminal box to be complete with attenuator or lined discharge duct in place. Maximum sound power levels in decibels and specific static pressure are scheduled on drawings for each size of box.

3 Execution

3.01 Installation of Terminal Boxes

- .1 Provide ceiling mounted terminal boxes.
- .2 Secure each box in place from structure by means of galvanized steel angles and hanger rods, independent of connecting ductwork.
- .3 Coordinate provision of transformers, actuators and controllers with Controls Contractor.
- .4 Connect each box with ductwork as indicated. Provide straight inlet duct same size as box inlet and of a length equal to a minimum of 4 duct diameters. Refer to drawing detail. Coordinate final box adjustments and settings with personnel doing system testing and balancing work.

3.02 System Startup

- .1 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.03 Training

- .1 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, and setting and adjusting controls.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Diffusers.
- .2 Registers/grilles.

1.3 REFERENCES

- .1 ADC 1062 - Air Distribution and Control Device Test Code.
- .2 AMCA 500 - Method of Testing Louvres for Ratings.
- .3 AMCA 5000 - Method of Testing Dampers for Ratings.
- .4 ARI 650 - Air Outlets and Inlets.
- .5 ASHRAE 70 - Method of Testing for Rating the Performance of Outlets and Inlets.
- .6 SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- .7 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS

- .1 Section 23 01 01: Procedures for submittals.
- .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.
- .3 Samples: Submit two of each required air outlet and inlet type.

1.5 PROJECT RECORD DOCUMENTS

- .1 Section 23 01 01: Submittals for project closeout.
- .2 Record actual locations of air outlets and inlets.

1.6 QUALITY ASSURANCE

- .1 Test and rate air outlet and inlet performance to ADC Equipment Test Code 1062.
- .2 Test and rate louvre performance to AMCA 500.

1.7 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with a minimum of three years documented experience.

2 Products

REFER TO DIFFUSERS & GRILLES SCHEDULE ON DRAWINGS

2.1 MANUFACTURERS

- .1 E. H. Price model indicated or equivalent products by;
 - .1 Titus
 - .2 Kreuger
 - .3 Metalaire
 - .4 Nailor

2.2 SQUARE CONE DIFFUSERS, FIXED PATTERN

- .1 Manufacturer's Reference: E. H. Price Model SCD
- .2 Type: Square, fixed pattern, stamped, multi-core diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated.
- .3 Frame: Inverted T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.
- .4 Fabrication: Steel with baked enamel off-white finish.
- .5 Accessories: Radial opposed blade damper and multi-louvred equalizing grid with damper adjustable from diffuser face.

2.3 CEILING GRID CORE EXHAUST AND RETURN GRILLES

- .1 Manufacturer's reference: E. H. Price 80D
- .2 Type: Fixed grilles of 1/2" x 1/2" x 1/2" (13 x 13 x 13 mm) louvres.
- .3 Frame: 1-1/4" (32 mm) margin with concealed mounting. Channel lay-in frame for suspended grid ceilings.
- .4 Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from Face.

2.4 ROUND CONE DIFFUSERS

- .1 Manufacturer's Reference: E. H. Price Model RCD
- .2 Type: Round, fixed pattern, stamped, multi-core diffuser to discharge air in 360-degree pattern with sectorizing baffles where indicated.

2.5 WALL GRILLES

- .1 Manufacturer's reference: E. H. Price 80D

3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's 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 and grilles and connect to ductwork with air tight connections.
- .4 Provide balancing dampers in duct take-off to diffusers, grilles and registers, whether or not dampers are included as part of the diffuser, grille or register assembly.
- .5 Paint visible ductwork behind air outlets and inlets matte black.
- .6 Install filters in diffusers, grilles and registers after final cleaning of rooms and ductwork has been completed and accepted and when environmental conditions are suitable. Ensure that air tight seal is achieved.
- .7 Provide balancing dampers in duct take-off to diffusers, return grilles etc whether or not dampers are shown on the drawings. Contractor is fully responsible to provide dampers required for proper balancing of the system.

End of Section

PART 1 - GENERAL

1.1 Submittals

- .1 Refer to Section 23 00 00 – General Mechanical Requirements.
- .2 Submit with shop drawings certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH when applicable.
- .3 Submittals without pump head versus flow curves will be discarded. Tabulated data is not acceptable.

1.2 Quality Assurance

- .1 Pumps shall be aligned by qualified millwright and alignment certified.
- .2 Ensure pumps operate at specified system fluid temperatures. Operate within 25% of midpoint of published maximum efficiency curve.
- .3 Polyphase, squirrel cage, single speed NEMA/EEMAC Design A or B induction motors, between 1 hp and 200 hp, whether in packaged equipment or not, shall comply with the current requirements of the Ontario Energy Efficiency Standards Regulation, and specifically, CSA C390-93 Energy Efficiency Test Methods for Three Phase Induction Motors.

1.3 Acceptable Manufacturers

- .1 Manufacturers of pumps whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 ITT – Bell & Gossett
 - .2 Armstrong
 - .3 Taco

1.4 Alternatives

- .1 Equivalent pump selections shall not change type, configuration, or motor power, increase noise level, increase speed by more than 10% or increase inlet velocity.
- .2 Alternative pump selections shall include plotted pump head vs. flow curves for both the proposed alternative pump and the specified pump on the same graph. The alternative pump curve shall exceed the specified pump performance and shall not cross the specified pump curve at any point.

PART 2 - PRODUCTS

2.1 General

- .1 Statically and dynamically balance rotating parts.
- .2 Construction shall permit complete servicing without breaking piping or motor connections.
- .3 Pumps shall operate at 1,750 rpm unless specified otherwise.
- .4 Pump connections shall be flanged for sizes 63mm (2½") and over.
- .5 Units shall be completely factory wired, tested and name-plated before shipment. Pump manufacturer shall be ISO-9001 certified.
- .6 Pumps shall meet types, sizes, capacities, and characteristics as scheduled on the equipment Schedule drawings. Refer to schedules for unit performance.
- .7 Units shall be specifically designed for chilled water and hot water heating systems as indicated on the drawings. Complete unit shall be ETL- Canada listed.
- .8 Pumps shall confirm to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless

otherwise approved by the engineer. The pump NPSH shall confirm to the ANSI/HI 9.6.1-1997 standards for *Centrifugal and Vertical Pumps for NPSH Margin*.

- .9 Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Pump and motors shall be factory aligned and shall be realigned (laser alignment) after installation by the manufacturer's representative. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications and conform to the standards outlined in EISA.
- .10 The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5-1994, section. 1.4.6.1.1 for recommended acceptable unfiltered field vibration limits (as measured per H.I. 1.4.6.5.2, Figure 1.108) for pumps with rolling contact bearings.
- .11 1.4.6.5.2, Figure 1.108) for pumps with rolling contact bearings.
- .12 Pumps shall be designed for operation at 225° F and 175 PSIG working pressure unless scheduled otherwise on the drawings.
- .13 Base mounted pumps shall have the seismic capability to withstand a horizontal load of 0.5g, excluding piping and/or fasteners used to anchor the pump to mounting pads or to the floor, without adversely affecting pump operation.

2.2 Base Mounted Hydronic Water Circulating Pumps

- .1 The pumps shall be long coupled, base mounted, single stage, end suction or double suction, vertical split case design, in cast iron bronze fitted construction.
- .2 Vertical split case pumps shall have a center drop-out type coupling between the pump and the motor. Coupler shall allow for removal of pump's rotating element without disturbing pump volute or movement of the pump's motor.
- .3 Pumps shall be capable of being serviced without disturbing piping connections, electrical motor connections or pump to motor alignment.
- .4 The bearing housing shall supply support for heavy-duty single row permanently lubricated ball bearings, with provision for purging or flushing if desired. The bearings shall be capable of absorbing both radial and thrust loads while maintaining the rotating element in proper axial alignment.
- .5 The impeller shaft shall be of solid 416 stainless steel material.
- .6 Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have a brass housing, seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
- .7 Pump volute shall be of a cast iron design with an integrally cast pump discharge and suction. Flanges shall be extra heavy-duty design and will be of 250# thickness while capable of being drilled for 125# ANSI flat face use. Volute shall have integrally cast support feet, gauge ports at nozzles, and vent and drain ports.
- .8 A coupling, capable of absorbing torsional vibration and of operating in variable speed applications, shall be employed between the pump and motor.
- .9 An ANSI B15.1 and OSHA 1910.219 compliant coupling guard shall shield the coupler during operation. Coupler guard shall contain viewing windows for inspection.
- .10 Motor base plate shall be welded structural steel fully enclosed at sides and ends, with securely welded cross members. The minimum base plate stiffness shall conform to ANSI/HI 1.3-2000, section 1.3.5.3 for *Horizontal Base Plate Design* standards.
- .11 Pump rotation shall be right-hand or left-hand as viewed from the pump's motor end and in respect to the discharge flange.
- .12 Provide Suction Diffusers as follows:
 - .1 Single suction diffusers shall consist of an angle type body with internal straightening vanes that run the full length of the diffuser and a combination diffuser/strainer/orifice cylinder with 3/16" diameter openings for pump protection.
 - .2 Double suction diffusers shall consist of a ductile iron double suction angle type body

with internal exiting vanes, integrally cast flanges, and a 1-1/2" blowdown connection. Internal design shall equally split half of the system flow to each side of a double suction type pump's impeller.

- .3 Diffusers for closed system operation shall be equipped with a readily replaceable start-up strainer.

2.3 Suction Diffuser

- .1 Provide suction diffuser for each pump.
- .2 Body: cast iron with flanged connections.
- .3 Strainer: with built-in disposable 1.19mm (3/64") mesh, low pressure drop screen and NPS 25mm (1") blowdown connection.
- .4 Permanent magnet particle trap.
- .5 Full length straightening vanes.
- .6 Pressure gauge tapings.
- .7 Adjustable support leg.
- .8 Manufacturer shall match pump manufacturer.

2.5 Triple Duty Valves

- .1 As per manufacturer's recommendations

PART 3 – EXECUTION

3.1 General

- .1 Contractor shall install pumps and suction guides in accordance with manufacturer's guidelines.
- .2 Triple duty valves are not acceptable. Install circuit balancing valve and check valve as per detail on drawings.
- .3 All electrical wiring and accessories, including power wiring from motor control centers and/or motor starter to driven motor, shall be installed in accordance with the requirements specified by Division 16 and the local electrical authority.
- .4 Furnish the services of a factory trained representative to review the installation, and to provide equipment Startup. Start-up shall include laser alignment of pump and motor assembly.
- .5 Remove temporary strainers after flushing is complete and leave in mechanical room for inspection/confirmation by the Consultant.
- .6 In-line heating pumps: install on stands with neoprene/steel/neoprene vibration isolator pads.
- .7 Base mounted heating pumps: supply and install concrete inertia bases complete with flexible pipe connectors on both the suction and discharge side of the pump. Inertia bases shall be 10" thick complete with 2" deflection springs. The inertia pad shall have reinforcement bars running in two directions on 9" centers, as well as locating anchors for the pump base. Level and grout the base according to manufacturer's instructions.
- .8 For inline circulating pumps, support piping adjacent to pump such that no weight is carried on pump casings. Do not provide supports directly on pump casings. Provide supports under elbows on pump suction and discharge line sizes 75mm (3") and over.

END OF SECTION

PART 1 - GENERAL

1.1 References

- .1 UL 508
- .2 NEC

1.2 Quality Assurance

- .1 To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.
- .2 All optional features shall be functionally tested at the factory for proper operation.

1.3 Submittals

- .1 Shop drawings must be submitted and reviewed by the Consultant prior to the contractor ordering or shipping any subject equipment. Payments will not be processed for equipment not properly documented and reviewed under the terms of submittal.
- .2 Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFDs FLA rating, certification agency file numbers and catalog information.
- .3 The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.
- .4 Submit a Harmonic Distortion Analysis for the jobsite location.
- .5 Harmonic filtering. The seller shall, with the aid of the buyer's electrical power single line diagram, providing the data required by IEEE-519, perform an analysis to initially demonstrate the supplied equipment will meet the IEEE standards after installation. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

1.4 Warranty

- .1 The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

1.5 Acceptable Manufacturers

- .1 Danfoss Graham
- .2 Trane TRC Series

PART 2 - PRODUCTS

- 2.1 Furnish complete variable frequency drives as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure, or other.

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- NEMA type according to the installation and operating conditions at the job site.
- 2.2 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to negate the need for motor derating.
 - 2.3 With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not be overloaded under operating conditions.
 - 2.4 The VFD shall include a fused disconnect where noted in the schedule.
 - 2.5 The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
 - 2.6 The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option panel, in the case where these are not contained in one panel. When these drives are to be located in Canada, the CSA or C-UL certifications shall apply. Both drive and option panel shall be manufactured in ISO 9001 certified facilities.
 - 2.7 The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 5% impedance line reactor.
 - 2.8 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
 - 2.9 The VFD shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.
 - 2.10 An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide a 3% to 10% additional energy savings.
 - 2.11 Input and output power circuit switching can be done without interlocks or damage to the VFD.
 - 2.12 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.
 - 2.13 Galvanic and/or optical isolation shall be provided between the drive's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. Drives not including isolation on both analog I/O and discrete I/O shall include additional isolation modules.
 - 2.14 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted optimizing motor and drive efficiencies while reducing motor noise. Drives not incorporating this feature shall have a fixed carrier frequency above 10 kHz without
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output current derating or reduced motor performance.

2.15 Protective Features

- .1 A minimum class 20 I²t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.
- .2 Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.
- .3 Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 164 volts for 208/230 volt units, and 313 volts for 460 volt units.
- .4 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
- .5 Drive package shall include semi-conductor rated input fuses to protect power components.
- .6 To prevent breakdown of the motor winding insulation, the drive shall be designed to comply with IEC Part 34-17. Otherwise the drive manufacturer must ensure that inverter rated motors are supplied.
- .7 Drive shall include a "signal loss detection" circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.
- .8 Drive shall function normally when the keypad is removed while the drive is running and continue to follow remote commands. No warnings or alarms shall be issued.
- .9 Drive shall catch a rotating motor operating forward or reverse up to full speed.
- .10 VFD shall be rated for 100,000 amp interrupting capacity (AIC).
- .11 Drive shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
- .12 Drive shall continue to operate without faulting until input voltage exceeds 300 volts on 208/230 volt drives, and 539 volts on 460 volt drives.

2.16 Interface Features

- .1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the drive and determine the speed reference.
- .2 Provide a 24 V DC output signal to indicate that the drive is in Auto/Remote mode.
- .3 Digital manual speed control. Potentiometers are not acceptable.
- .4 Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.
- .5 All keypads shall be identical and interchangeable.
- .6 To setup multiple drives, it shall be possible to upload all setup parameters to the drive's keypad, place that keypad on all other drives in turn and download the setup to each drive.
- .7 Display shall be programmable to display in 9 languages including English, Spanish and French.
- .8 The display shall have four lines, with 20 characters on three lines and eight large characters on one line.
- .9 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the drive when the keypad is removed.
- .10 A quick setup menu with factory preset typical HVAC parameters shall be provided on the drive eliminating the need for macros.
- .11 The drive shall be fitted with an RS 485 serial communications port and be supplied with
 - a. Windows[®] compatible software to display all monitoring, fault, alarm and status signals. The software shall allow parameter changes to be made to the drive settings, as well as storage of each controller's operating and setup parameters, and remote operation of the drive. The same software shall be used throughout the entire product range.

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- .12 The drive shall include as standard RS-485 communications capabilities to be connected at a future date to Johnson Controls N2 and/or Siemens Landis Division System 600 FLN at no additional cost to the owner. The connection shall be software selectable by the user.
 - .13 As a minimum, the following points shall be controlled and/or accessible:
 - .1 Drive start/stop
 - .2 Speed reference
 - .3 Fault diagnosis
 - .4 Meter points
 - .5 Motor power in kW
 - .6 Motor power in HP
 - .7 Motor kW/hr
 - .8 Motor current
 - .9 Motor voltage
 - .10 Hours run
 - .11 Feedback signal #1
 - .12 Feedback signal #2
 - .13 DC link voltage
 - .14 Thermal load on motor
 - .15 Thermal load on drive
 - .16 Heatsink temperature
 - .14 Two set-point control interface (PID control) shall be standard in the unit. Drive shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
 - .15 The sleep mode shall be functional in both follower mode and PID mode.
 - .16 Floating point control interface shall be provided to increase/decrease speed in response to switch closures.
 - .17 Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. Drives unable to show these four displays simultaneously shall provide panel meters.
 - .18 Sleep mode shall be provided to automatically stop the drive when speed drops below set "sleep" level for a specified time. Drive automatically restarts when speed command exceeds set "wake" level.
 - .19 Run permissive circuit shall be provided to accept a "system ready" signal to assure that the drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
 - .20 An elapsed time meter and kWh meter shall be provided.
 - .21 The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature in degrees, and Motor Speed in engineering units per application (in percent speed, GPM, CFM,...). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
 - .22 The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application and temperature (°F) for a cooling tower application.
 - .23 Four meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive's response to that signal for ease in commissioning.
 - .24 Drive will sense the loss of load and signal a no load/broken belt warning or fault.
 - .25 If the temperature of the drive's heat sink rises to 80°C, the drive shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise,

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- the drive shall automatically reduce its output frequency to the motor. As the drive's heat sink temperature returns to normal, the drive shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
- .26 The VFD shall have temperature-controlled cooling fans for quiet operation and minimized losses.
 - .27 The VFD shall store in memory the last 20 faults and record all operational data.
 - .28 Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
 - .29 Two programmable relay outputs, one Form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.
 - .30 Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 V dc, 0-20 mA and 4-20 mA.
 - .31 Two programmable 0 to 20 mA analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.
 - .32 Under fire mode conditions the VFD shall automatically default to a preset speed.

2.17 Adjustments

- .1 VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning of drive to motor.
- .2 Sixteen preset speeds shall be provided.
- .3 Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping. Four current limit settings shall be provided.
- .4 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit, inverter overload and motor overload.
- .5 The number of restart attempts shall be selectable from 0 through 20 and the time between attempts shall be adjustable from 0 through 600 seconds.
- .6 An automatic "on delay" may be selected from 0 to 120 seconds. both drive and bypass mode.

2.18 Bypass

- .1 A 3-contactor bypass shall be provided on all VFD's serving heating pumps or glycol pumps.
- .2 Bypass is not required for air handling unit or rooftop units. Provide a manual 3-contactor bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in DRIVE or BYPASS mode in case of an external safety fault.
- .3 Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power. This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.
- .4 Smoke purge circuitry shall be interconnected such that an external dry contact can be used in both drive and bypass mode.
- .5 A 3-contactor bypass shall be provided on all VFD's serving heating pumps or glycol pumps.
- .6 Bypass is not required for air handling unit or rooftop units.
- .7 Provide a manual 3-contactor bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from

the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in

- .8 DRIVE or BYPASS mode in case of an external safety fault.
- .9 Service personnel shall be able to defeat the main power disconnect and open the bypass
- .10 enclosure without disconnecting power This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.
- .11 Smoke purge circuitry shall be interconnected such that an external dry contact can be used in both drive and bypass mode.

2.19 Service Conditions

- .1 Ambient temperature, -10 to 40°C (14 to 104°F).
- .2 0 to 95% relative humidity, non-condensing.
- .3 Elevation to 3,300 feet without derating.
- .4 AC line voltage variation, -10 to +10% of nominal with full output.
- .5 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

PART 3 - EXECUTION

3.1 Start-up Service

- .1 The manufacturer shall provide start-up and commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Start-up shall include customer operator training at the time of the equipment commissioning.

3.2 Examination

- .1 Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.
- .2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

- .1 Packaged Roof Top Air conditioning units.
- .2 Controls.

1.3 REFERENCES

- .1 ARI 210/240 - Unitary Air-Conditioning Equipment.
- .2 ARI 270 - Sound Rating of Outdoor Unitary Equipment.
- .3 ASHRAE/IESNA 90.1 - Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

1.4 SUBMITTALS FOR REVIEW

- .1 Product Data: Provide drawings indicating dimensions, rough-in connections, and electrical characteristics and connection requirements.

1.5 SUBMITTALS FOR INFORMATION

- .1 Section 23 01 01: Submittals for information.
- .2 Submit manufacturer's installation instructions. Indicate assembly, support details, connection requirements, and include start-up instructions.

1.6 SUBMITTALS FOR CLOSEOUT

- A. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation, and Maintenance manual with startup requirements shall be provided.
- B. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.
- C. Section 23 01 01: Submittals for project closeout.
- D. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.7 QUALITY ASSURANCE

- A. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- B. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

- C. Unit shall be certified in accordance with ANSI Z21.47b/CSA 2.3b and ANSI Z83.8/CSA 2.6, Safety Standard Gas-Fired Furnaces.
- D. Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- E. Unit shall be certified by ETL and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label. The nameplate, safety labels and warnings will be in English and French.

1.8 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 23 01 01: Transport, handle, store, and protect products.
- .2 Protect finished cabinets from physical damage by leaving factory packing cases in place before installation and providing temporary covers after installation.

1.10 WARRANTY

- .1 Section 23 01 01: Submittals for project closeout.
- .2 Warranty Period:
 - .1 Refrigeration System: Manufacturer's standard, minimum two years from date of Substantial Completion, including components and labour.
 - .2 Other Parts: Manufacturer's standard, minimum two years from date of Substantial Completion, including only components and excluding labour.

2 PRODUCTS

2.01 Manufacturer

- A. Products shall be provided by the following manufacturers:
 - 1. Base of design is AAON, Roof Top Units meeting specifications by Carrier, Trane & York will be treated as equal.
 - 2. The contractor shall furnish and install packaged outdoor rooftop units as shown and scheduled on the contract documents. The units shall be installed in accordance with this specification and perform at the specified conditions as scheduled.
 - a. Stainless steel drain pans
 - b. Hinged access doors with lockable handles
 - c. Stainless steel furnace with minimum 25 year furnace warranty
 - d. All other provisions of the specifications must be satisfactorily addressed

2.02 Rooftop Units

- A. Furnish as shown on plans, Daikin Applied Rebel Single Zone Heating and Cooling Unit(s) model DPS. Unit performance and electrical characteristics shall be per the job schedule.
- B. Configuration: Fabricate as detailed on prints and drawings:
 - 1. Return plenum / economizer section

-
- 2. Filter section
 - 3. Cooling coil section
 - 4. Supply fan section
 - 5. Gas heating section.
 - 6. Condensing unit section
 - C. The complete unit shall be cETLus listed.
 - D. The unit shall be ASHRAE 90.1-2019 compliant and labeled.
 - E. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-32 Refrigerant and oil.
 - F. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
 - G. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
 - H. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.
 - I. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

2.02 CABINET, CASING, AND FRAME

- A. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0 on sizes 3-17 tons, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
- B. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16" at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
- C. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless-steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- D. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal.

2.03 OUTDOOR/RETURN AIR SECTION

- A. Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside

and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in accordance with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.

- B. Daikin Applied UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.
- C. Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when supply fan starts, and close when supply fan stops.

2.04 ENERGY RECOVERY

- A. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
- B. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.
- C. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning
- D. The unit shall have 2" Merv 8 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.
- E. The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless-steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
- F. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- G. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.
- H. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.

- I. The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor, or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed
- J. The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.
- K. The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. The energy recovery wheel shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.
- L. The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

2.05 EXHAUST FAN

- A. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- B. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- C. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.06 FILTERS

- A. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

2.07 COOLING COIL

- A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
- B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
- C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
- D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.08 SUPPLY FAN

- A. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- B. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- C. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.09 VARIABLE AIR VOLUME CONTROL

- A. The unit controller shall proportionally control the Electronically Commutated Motors (ECM) on the supply and exhaust fans. The supply fan shall be controlled to maintain an adjustable duct pressure setpoint. A duct static pressure sensor shall be factory mounted in the control panel. The field shall furnish and install the pneumatic tubing for the duct static pressure sensor and the building pressure sensor. The field shall furnish and install the outdoor air pressure sensor.
- B. The supply air fan drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel.

2.010 HEATING SECTION

- A. The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.
- B. The module shall be complete with furnace controller and control valve capable of 10:1 modulating operation.
- C. The heat exchanger tubes shall be constructed of stainless steel
- D. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
- E. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.
- F. The factory installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

2.011 HEAT PUMP HEATING

- A. The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4-way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
- B. The refrigerant system shall have a pump-down cycle.

C. The unit shall have a natural gas furnace for hybrid heating. When the heatpump operation cannot maintain the discharge air temperature setpoint the natural gas furnace shall temper the airstream to the discharge air temperature setpoint.

2.012 CONDENSING SECTION

- A. Outdoor coils shall have seamless copper tubes, mechanically bonded into aluminum plate-type fins. The fins shall have full drawn collars to completely cover the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
- B. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit in ambient conditions up to 125°F]. Mechanical cooling shall be provided to 0°F. Heat Pump Heating shall be provided to -10°F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- C. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.
- D. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. [The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line.
- E. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
- F. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
- G. Each circuit shall be dehydrated and factory charged with R32 Refrigerant and oil.

2.013 ELECTRICAL

- A. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.
- B. A GFI receptacle shall be unit mounted that is field powered.
- C. A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

2.014 CONTROLS

- A. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.

B. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.

C. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.

D. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.

E. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to ensure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.

F. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:

1. Return air temperature
2. Discharge air temperature
3. Outdoor air temperature
4. Space air temperature
5. Outdoor enthalpy, high/low
6. Compressor suction temperature and pressure
7. Compressor head pressure and temperature
8. Expansion valve position
9. Condenser fan speed
10. Inverter compressor speed
11. Dirty filter indication
12. Airflow verification
13. Cooling status
14. Control temperature (Changeover).
15. VAV box output status
16. Cooling status/capacity
17. Unit status
18. All time schedules
19. All time schedules
20. Previous alarms with time and date
21. Optimal start
22. Supply fan and exhaust fan speed
23. System operating hours

G. The user interaction with the keypad shall provide the following:

1. Controls mode
2. Cooling and heating change-over temperature with deadband
3. Cooling discharge air temperature (DAT)
4. Supply reset options

5. Temperature alarm limits
6. Lockout control for compressors
7. Compressor interstage timers
8. Night setback and setup space temperature
9. Building static pressure
10. Economizer changeover
11. Currently time and date
12. Tenant override time
13. Occupied/unoccupied time schedule
14. One event schedule
15. Holiday dates and duration
16. Adjustable set points
17. Service mode

H. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:

1. Zone sensor with tenant override switch
2. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)

I. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:

1. Airflow
2. Outside air temperature
3. Space temperature
4. Return air temperature
5. External signal of 1-5 vdc
6. External signal of 0-20 mA
7. Network signal

J. The microprocessor controls shall be solely dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. No commissioning settings shall be lost, even during extended power shutdowns.

K. The microprocessor controls shall be dependent on starting and stopping of the unit via terminal strip control and logic. The control system shall be capable of providing a remote alarm indication. The microprocessor shall provide compressor capacity & status, defrost status (heat pump only), condensate overflow alarm, and dirty filter alarm.

L. All digital and analog inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.

M. The keypad interface shall allow convenient navigation and access to the commissioning functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:

1. Supply and exhaust fan speed control
2. Refrigeration alarm details.

2.015 A2L Leak Mitigation Refrigerant Detection System (RDS) for compressorized rooftop equipment using A2L refrigerant.

A. Compressorized rooftop equipment using A2L refrigerant shall come equipped with a factory installed Refrigerant Detection System (RDS) in compliance with UL60335-2-40. The factory-installed unit controller will respond and control

the unit to comply with UL60335-2-40 according to the alarm status of the refrigerant detection system. See the unit Operations Manual for a detailed sequence of operations.

B. The Refrigerant Detection System (RDS) shall consist of the following components:

1. Dedicated A2L Refrigerant Detection Control Board
2. Refrigerant Sensor or Sensors. The number of sensors will vary based on the product and configuration as needed to comply with UL requirements.

C. Operation and Monitoring:

1. The refrigerant sensor or sensors communicate with the refrigerant detection control board. The refrigerant sensors detect the presence of the A2L refrigerant outside of the sealed refrigeration piping and communicate the levels to the refrigerant detection control board. The refrigerant detection controller communicates the RDS status to the factory-installed unit controller.
2. Alarm Communication: The unit controller will communicate RDS alarms based on the RDS status in the same way as any other alarm. Alarms are triggered by the following: 1) Refrigerant detected above 15% of the refrigerant lower flammability level (LFL); 2) Refrigerant Sensor Fault.
 - a. A customer relay is provided for the field to connect directly to the refrigerant detection control board as an alternative means to receive the above two alarm statuses.
 - b. A customer relay is provided for the field to connect directly to the refrigerant detection control board as an alternative means to receive the above two alarm statuses.

D. Factory unit wiring diagrams must show the refrigerant leak detection system wiring.

2.016 ROOF CURB

A. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 24" high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.

Part 3 - Execution

3.01 Installation, Operation, and Maintenance

- A. Installation, Operation, and Maintenance manual shall be supplied with the unit.
- B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation, and Maintenance manual instructions.
- C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

End of Section

1 General

1.1 General Requirements

- .1 Comply with General Requirements of Section 23 01 01.

1.2 Section Includes

- .1 Wallfins
.2 Cabinet unit heaters.
.3 Baseboard heaters- electric

1.3 Quality Assurance

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.4 Regulatory Requirements

- .1 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

1.5 Warranty

- .1 Section 23 01 01: Submittals for project closeout.

2 Products

2.1 Wallfins

All radiators shall be as manufactured by Sigma or approved equal. Sizes and outputs are as indicated on the drawings and/or schedule. Radiator manufacturer shall have a minimum 10 years' experience in manufacturing and a history of North American installations.

2. Radiators shall be of one-piece all-welded steel construction, consisting of a pair of flattened water tube panels welded to headers at each end. Some models include welded to the inside of each panel, steel corrugated fins to increase the convective output of the radiator. The fins shall start at no less than 3" from the end of the radiator, and shall have no less than 32 fins per foot. The radiators shall include an integral heavy gauge (0.09" minimum) all-welded perforated top grille, which will cover the top of all of the finned areas.
3. The headers shall include all necessary inlet, outlet and vent connections as required. Standard connection sizes are 1/2" NPT tapered thread for supply and return piping, and 1/8" for the vent connection. Internal baffling is provided where required for proper water flow.
4. The radiant heating panels shall be available in lengths from 2'-0" to 29'-6" in two inch even increments without the need for splicing. The panel radiation shall be capable of being mounted to typical stud wall construction without additional blocking or strapping.
5. Units shall of standard pressure construction rated for 56 psi and tested at 74 psi.
- Optional; MEDIUM: Working pressure-85 PSI maximum, Test Pressure-110 PSI maximum
HIGH: Working pressure-128 PSI maximum, Test Pressure 184 PSI maximum
6. The units shall be rated and tested in accordance with the International Standards Organization ISO 3147-3150. BTU/Hr capacities have been adjusted for 65°F Entering Air Temperature and 15% Heat Effect.
7. Radiator expansion shall not exceed 1/64"/foot (1 mm/meter) at 215°F (100°C). The installer shall provide adequate expansion compensation for each radiator.

8. The panel radiation shall be cleaned and phosphatized in preparation for the powder coat finish. The radiation is then finish painted with a gloss powder coat finish, for a total paint thickness of 2-3 mils (0.002" - 0.003"). The color shall be selected from the Runtal's 10 standard color range.
Optional: optional colors shall be available at an additional cost.
9. Wall mounting brackets and hold off bolts shall be provided with the units where required. Free standing floor posts shall be provided with the units where required. Posts shall be painted the same color as the radiators. Any strengthening of the walls or floors required to support the weight of the "wet" unit shall be by others.
10. Manual air vents are to be supplied with the radiators.
11. Ribbed pipe cover trims, finished to match the radiators shall be provided with the panels.
12. Where noted active radiators shall be supplied with a low surface temperature panel manufactured from the same flattened water tubes as the active radiators, including an all-welded perforated top grille. On pedestal mounted units the low surface temperature panel shall be on the backside of the radiator as well. Inactive panel shall extend beyond the active radiator and provide a wall to wall appearance.
13. Units mounted at high level shall be supplied with an all-welded perforated bottom grille. The ribbed pipe covers shall be suitable for inverted mounting.
14. On the return connection, radiators are to be provided with a Oventrop Combi 4 lockshield valve, for isolation and to incorporate draining/filling capabilities. On the supply side a Combi 2 valve is to be provided for isolation purposes. The valves are to be nickel plated and supplied with union and tailpiece.
Combi 4 valves shall be provided with a service tool to operate the valves. The service tool is to be turned over to the owner.

2.2 Cabinet Unit Heaters

- .1 Cabinets
Cabinets Are Constructed From 18 Gauge Galvanneal Corrosion-Resistant Steel with A Durable Grey Baked on Powder Coat Finish. Enhanced Corrosion Protection Options Are Available. These Include Stainless Steel or Enhanced Coating Such as Heresite. Back Panels on The Air-Inlet Side Have Integral Fan Inlet Collars for Additional Stiffness and Enhanced Air-Side Performance.
- .2 Louvres
All Louvre Blades Have Rugged Retaining Springs Keeping Blades At Their Set Position. These Springs Permit Unlimited Blade Adjustment Over the Unit's Life Without Decreasing The Blade Holding Force.
- .3 Coils
Coils are constructed from heavy-duty minimum 1/2" diameter copper tubes with mechanically bounded Aluminum fins. All coils are pressure-tested at no less than 450 psig and are rated for design pressures of up to 360 psig across all standard models.
- .4 Fans
All fans are statically and dynamically balanced. The entire fan-motor assembly or horizontal unit heaters with standard motors 1/2 HP and smaller are supported by a sturdy wire-form mount, which in itself is a fan guard that meets OSHA standard. The fan blades are aluminum and as such all units comply with AMCA. Type c spark-resistant construction.
- .5 Motors
Standard 120/1/60 motors are of TEAO (totally enclosed air-over) construction, with up to 1/2 HP motors having built-in automatic thermal overload protection. All other motor types and sizes will require an external overload feature. Standard motors are resilient mounted for quiet, low-vibration operation and are ideally suited for a long trouble-free life. Air-over implies that the motor requires air movement provided by other means for its cooling. Since all unit heaters inherently draw ambient air over the motor via its driven axial fan, ample motor cooling is achieved without requiring a more expensive and energy consuming TEFC (totally enclosed fan-cooled) motor.

Explosion-proof motors are optional. NEMA 4/4x or washdown rated motors are available.

.6 Optional Control Accessories

All units come equipped with an electrical junction box for simple field electrical hook-up. Optional unit mounted or remote-control accessories include but are not limited to the following:

- Disconnect Switch
- Manual Starter Switch with Overload
- Thermostat
- Aquastat
- Speed Control
- Low Voltage Motor Rated Relay with Or Without Transformer

2.3 Force Flow Heaters

.1 Cabinets

The outer cabinet shall be constructed of heavy-duty corrosion resistant 16 Ga steel. The removable front panel shall provide uninhibited access to the motor, fans, controls and coil. Cabinets shall be available in a left- or right-hand configurations. Cabinets shall be a standard factory finish in grey primer.

.2 Coils

Heating coils shall be manufactured from 1/2" outside diameter seamless copper tubes which are expanded within corrugated aluminum fins. The coils shall be designed for working pressures of up to 150 psi.

.3 Blowers

Blowers shall be twin centrifugal double-inlet double width fans mounted onto double-shafted motors.

Where 1200 and 1500 cfm units are specified, they shall employ a pair of twin fan & motor assemblies. All fan wheels and fan housings shall be corrosion resistant.

.4 Motors

Motors shall be permanent split capacitor type with self-aligning sleeve bearings and internal overload protection.

.5 Filters

Filters shall be supplied with wire framed polyester media filters as standard.

.6 Controls and Other Standard Options

Units shall include optional features as follows:

1. 3 Speed Control with Off Position
2. Remote or unit mounted line voltage thermostat
3. Remote mounted line voltage thermostat
4. Unit mounted aquastat
5. Manual starter switch with overloads
6. High static motor for ducted units (not an option for 1000 and 1500 CFM units)
7. Factory applied powder coat finish
8. Grey primer finish for field paint
9. Inlet and discharge:
 - Punched Louver
 - Aluminum baffle (clear anodized finish)
10. Torx-plus security fasteners for main access panel
11. Slotted or keyed access door
12. 1/2" thick glass fiber black mat insulation
13. One, two, or three row water coils

Electric Baseboard Heaters:

1. Approved manufacturer: Oulette
2. Color Standard: white, almond.
3. Finish: Standard: epoxy/polyester powder paint.
4. Voltage : 120V, 208V, 1-phase.

Construction

-
- 20-gauge steel connection box.
 - 22-gauge steel body.
 - 20-gauge steel front panel.
 - Rounded upper corners.
 - Linear high-limit temperature control with automatic reset.

Heating element

- Stainless steel tubular heating element with aluminum fins.
- Floating heating element on high-temperature nylon bushings reducing expansion noises.

Watt density

- Average standard watt density of 275W/ft.
- Average low watt density of 200W/ft.

Control

- Built-in mechanical thermostat kit can be installed at either end.
- Baseboard section with built-in electronic thermostat can be installed at left end only (240V only).
- Built-in electronic thermostat installed in the right-hand junction box only. Only compatible with devices manufactured after 14-10-2019.
- Built-in relay kit fits in the right end box only.
- A compartment for low voltage connections (located directly under the junction box) facilitates the installation of low voltage relay in electric baseboard. Ouellet highly recommends the use of an electronic wall thermostat for greater comfort.

Installation

- Installation directly on the floor.
- Connection box at both ends of the heater.
- Single-screw built-in wire holder.
- Optional kit for installing an AC90 type electrical cable (BX).
- Raceway for ease of installation.
- Two rows of mounting holes spaced on 1 in. (25.4 mm) intervals for ease of installation.
- Variety of accessories available for wall-to-wall installation.

Warranty

- 5-year warranty against defects. • Heating element has a lifetime warranty for the initial end user.

3 Execution

3.1 Installation

- .1 Install to manufacturer's 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 Force Flow Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.
- .6 Hydronic Units: Provide with shut-off valve on supply and lockshield balancing valve on return piping. If not easily accessible, extend vent to exterior surface of cabinet for easy servicing. for cabinet unit heaters, fan coil units, and unit heaters, provide float operated automatic air vents with stop valve.

3.2 Cleaning

- .1 After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- .2 touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials provided by manufacturer (VOC content not to exceed 250 g/L).
- .3 Install new filters.

End of Section

-
- 1 General
 - 1.1 General Requirements
 - .1 Comply with General Requirements of Section 23 01 01.
 - 1.2 Section Includes
 - .1 Indoor overhead mounted, electrically controlled positive pressure radiant tube type infrared heating unit utilizing gas combustion for heating of spaces or areas.
 - 1.3 Quality Assurance
 - .1 Heater will be tested in accordance with ANSI Z83.20-2004 / CSA 2.34-2004 Standards, and certified by CSA International.
 - .2 Each heater burner will be subjected to run testing on the assembly line.
 - .3 The heater will be warranted by the manufacturer for defects in material and workmanship for a period of ten (10) years on the ceramic burner cup, combustion and heat exchanger tubes, and three (3) years on all other heater components.
 - 1.4 Warranty
 - .1 Section 23 01 01: Submittals for project closeout.
 - 1.5 Acceptable Manufacturers
 - .1
 - 2 Products

- 2.1 Equipment (Standard)

Site assembled, modular infrared radiant heating unit for overhead mounted space or area heating application. Supplied with the heater as required for field installation and start-up will be a burner with all necessary factory installed wiring, piping, and controls and a radiant tube/reflector system, complete with hangers and end plates, corresponding in length to the burner input. The radiant tube type infrared heating unit(s) will be manufactured by Schwank. Heater size(s) and capacity(s) are as noted on drawing and/or schedule

- .1 Emitting Tube System:

- a. All tubes will be 4 inch (100 mm) diameter with an emitting surface area of 152 in (982 cm) per linear foot (305 mm)
- b. For inputs up to and including 155,000 Btuh (45 kWh) the 10 foot (3050 mm) combustion tube adjoining to the burner will be constructed of 16 gauge aluminized steel.
- c. For inputs greater than 155,000 Btuh (45 kWh) the 10 foot (3050 mm) combustion tube adjoining to the burner will be constructed of 16 gauge alumatherm with a subsequent 10 foot (3050 mm) length of 16 gauge aluminized steel
- d. The balance of the heat exchanger tube system (lengths as approved for burner input) will be 10 ft (3050 mm) lengths of 16 gauge hot rolled steel
- e. Hot rolled heat exchanger tubes will be coated with a high temperature emissive coating
- f. The system tubes will have a swage of approximately 4 inches (100 mm) in length to accommodate the connection of subsequent tubes and vent pipe at the heater termination.
- g. Each tube connection in the system will be secured in place with a 4 inch (100 mm) TorcTite® coupler
 - i. For burner inputs of 100,000 Btuh (29 kWh), 175,000 Btuh (51 kWh) and 200,000 Btuh (58.5 kWh) a special coupling system will be used for securing the connection of the combustion chamber tube to the first heat exchanger tube as indicated in the Installation and Owners Manual

.2 Reflector Shield System:

- a. Reflector shields will be constructed of high-grade steel with a heat and corrosion resistant hot-bonded aluminum-silicon alloy coating.
- b. The reflector system will enclose the emitting tube system on the top and two sides and extend 1-5/8 (41mm) below the bottom surface of the tube system to entrap convection heat around the tube system, thereby increasing overall tube temperature and infrared heat emission.

.3 Tube/Reflector Suspension System:

- a. The tube/reflector system will have aluminized-steel sheet metal end caps at each end of the system to act as hanging brackets that will support the system and minimize the escape of entrapped convection heat.
- b. The tube/reflector system will have open-webbed hangers at each tube connection that will serve to join reflectors, act as intermediate supports for the system, and allow the free passage of entrapped convection heat along the length of the system to promote more uniform heat from end to end
- c. The tube/reflector end caps and hangers will enable suspension of the system so that the reflector shields can be oriented about the short axis of the system at a fixed angle between 0° to 45° as indicated on the drawings.
- d. The entire tube/reflector system will be suspended from the structure as indicated in the Installation and Owner's Manual or as specified in the drawings and/or schedule.

.4 Burner:

- a. The burner will have a blower to create a positive pressure system.
- b. The blower will provide combustion air flow directly to the burner assembly so that electronic burner components are isolated from the air flow
- c. The blower will be fitted with a 4-inch (100 mm) diameter collar in case site conditions warrant connection of outside combustion air
- d. The burner will operate on either natural gas or propane gas
- e. The burner will utilize a burner cup with ceramic tile that uses coaxial flow control elements. to create a very **long, laminar and axially straight flame**.
- f. The burner will be housed in a pre-painted sheet metal protective cabinet
- g. The burner cabinet will be of a 'clamshell' design that opens downward on a hinge to provide service access to all burner components.
- h. The burner will operate with the housing cabinet in the 'open' service position.

.5 Controls and Safeties:

1. General

- a. Electrical Rating: The burner will operate on a 115Vac, 60Hz electrical supply with a current rating of no less than 1.5A at 115Vac.
- b. Heater gas and ignition controls will be readily accessible for servicing.
- c. The burner will have solid state direct spark ignition and flame sensor control that is dedicated to securing the operation of the burner.

2. Ignition and Flame Control:

- a. To complete the direct spark ignition system the burner will incorporate a gas control and 25Vac transformer.

- b. Burner will be complete with a low voltage (25Vac), solid state direct spark ignition and ionization flame sensing control module that will provide a 30 second pre-ignition purge of the system by the blower. Electrical Rating: 25Vac, 60Hz with current rating of 0.2A at 25Vac
- c. Burner will be complete with an igniter/sensor to provide spark ignition and flame sensing.
- d. The ionization module will sense the presence of main burner flame and discontinue spark ignition. If the burner fails to ignite within the trial-for-ignition period, the flame control will go into safety lockout. Reset of the control is manually done from the thermostat.
- e. The ionization module will check for a false flame condition (short to ground) and lock out if a false flame condition is present.
- f. The ignition module will have a 21 second trial-for-ignition period
- g. The ignition module will open the main gas valve and generate 30,000 volts at the spark igniter for direct ignition of the burner.
- h. On a loss of burner flame the timed trial-for-ignition is repeated. Safety lockout occurs if flame is not reestablished within the 21 second trial-for-ignition period. Reset of the control is manually done from the thermostat or electrical supply.

3. Gas Control:

- a. Heater will be complete with a direct ignition gas control with a manual valve, two automatic operators, and a pressure regulator Electrical Rating: 24Vac, 60Hz; draw 0.5A with both operators energized.
- b. The gas control will have an inlet pressure tap and an outlet pressure tap to facilitate measurement of gas supply and manifold pressures during servicing.
- c. Heater will be complete with a ½" pipe nipple for connection to the gas supply.

4. Heater Temperature Control:

- a. Burner will be complete with a 24/120Vac relay switch; inclusion or removal of a jumper wire will enable control of the heater using an optional thermostat of 120Vac or 24Vac
- b. If multiple heaters are to be controlled in a zone by a single 24Vac thermostat, an optional Transformer/Relay as supplied by the manufacturer must be employed in the system
- c. Space Heating: Each heater zone will be controlled by a 24 Vac infrared set-back thermostat (refer Part 4A), or other 24 Vac or 120Vac thermostat as supplied by the manufacturer

5. Safety Controls:

- a. Burner will be complete with a pressure switch in the ignition system electrical circuit that will close upon proving a sufficient supply of combustion air from the blower
- b. Burner will further be complete with a separate pressure switch in the ignition system electrical circuit that will open upon pressure resulting from a blocked flue condition in the tube system

6. Exhaust Requirements:

- a. Direct Vented gas fired infrared heating system installation will comply with the manufacturer's installation instructions, the current National Natural Gas and Propane installation Code and all applicable local codes using:
 - i. A 4 inch (100 mm) vent pipe of a gauge prescribed by national and/or local codes
 - ii. Two heaters may be common vented using a 4 inch x 4 inch by 6 inch (100 mm x 100 mm x 150 mm) vent tee as supplied by the manufacturer; common vented heaters will be controlled by one common thermostat
- b. Indirect Vented Installation in Canada:

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- i. Gas fired infrared radiant heating system installation will comply with the manufacturer's installation instructions, the current national Natural Gas and Propane Installation Code B149.1 and all applicable local codes.
 - ii. The gas fired infrared radiant heating system will be provided with mechanical ventilation at a rate of 300 cfm for each 100,000 Btuh system input or fraction thereof. The ventilation system will be interlocked so that any reduction of the ventilation rate will cause the shutdown of the interlocked heater or group of heaters.

.7 Electrical Requirements:

- a. Power supply wiring (115Vac, 60Hz, with a current rating of no less than 1.5A at 115Vac) will connect to the heater as per the wiring diagram in the manual supplied by the manufacturer.

3. Execution

3.1 Installation

- i. Install to manufacturer's instructions.
- ii. Direct Vented gas fired infrared heating system installation will comply with the manufacturer's installation instructions, the current National Natural Gas and Propane installation Code and all applicable local codes using:
 - a. A 4 inch (100 mm) vent pipe of a gauge prescribed by national and/or local codes
 - b. Two heaters may be common vented using a 4 inch x 4 inch by 6 inch (100 mm x 100 mm x 150 mm) vent tee as supplied by the manufacturer; common vented heaters will be controlled by one common thermostat.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Read and conform to:
 - .1 The Contract **CCDC 2-2008**, Stipulated Price Contract as amended,
 - .2 Division 1 requirements and documents referred to therein.
- .2 Section 25 01 01 applies to and governs the work of all Sections of Mechanical Division.
- .3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..
- .4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.
- .5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

1.2 DEFINITIONS

- .1 The following are definitions of words found in this specification and on associated drawings under this Division:
 - .1 "Concealed" - locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
 - .2 "Exposed" - mechanical work normally visible to building occupants.
 - .3 "Furnish" - (and its derivatives) has the same meaning as the term "Supply".
 - .4 "Install" - (and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
 - .5 "Provide" - (and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
 - .6 "Supply" - (and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
 - .7 "Wet" - locations exposed to moisture, requiring special materials and arrangement.

1.3 WORK INCLUDED

- .1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
- .2 Cutting and patching of new or existing work
- .3 Excavating and backfilling
- .4 Identification of equipment, piping, ductwork, and valves and controllers
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches.
- .6 Motors required for equipment supplied under this Division.
- .7 Variable frequency drives for motors and equipment supplied under this Division.
- .8 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.
- .9 Disconnect switches for exhaust fans located on the roof complete with;
 - .1 EEMAC 1 enclosure if housed within a weatherproof cabinet,

- .2 EEMAC 3 enclosure if exposed to weather
- .10 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and construction of the new addition. Coordinate this protective work with all trades.
- .11 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.
- .12 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.4 RELATED WORK

- .1 Power wiring, conduit and connections for motors under this Division will be by Division 26.
- .2 Power wiring, conduit and connections to variable frequency drives for motors under this Division will be by Division 26. Wiring and connections from VFD to motors under this Division will be by Division 26.
- .3 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.
- .4 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches will be provided under Division 3.

1.5 SUBMITTALS

- .1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.
- .2 Shop Drawings: Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.
 - .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
 - .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
 - .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.
 - .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:
"This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."
- .3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Mechanical Division. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.

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- .4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.
 - .5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:
 - .1 description of the system (description and type),
 - .2 description of the tests conducted and results observed, including re-testing, where necessary,
 - .3 description of any corrective measures undertaken,
 - .4 description of materials used (pipe and fittings),
 - .5 list of witnesses for each test conducted,
 - .6 date system left ready for service,
 - .7 signature of installing Contractor.
 - .6 Directories & Schematics
 - .1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service, and location of each valve under this Division.
 - .2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.
 - .3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.
 - .7 Maintenance Data and Operating Instructions
 - .1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.
 - .2 Ensure the binder spines have typewritten lettering as follows:
OPERATION & MAINTENANCE MANUAL
for
[Insert name of project]
[Insert date of submission]
[Insert Division Title]
 - .3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.
 - .4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.
 - .5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.
 - .6 Ensure operating instructions include the following:
 - .1 General description of each mechanical system.
 - .2 Step by step procedure to follow in putting each piece of equipment into service.
 - .3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
 - .4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.
 - .5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.
 - .7 Ensure maintenance instructions include the following:
 - .1 Manufacturer's maintenance instructions for each item of mechanical equipment

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- installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.
- .2 Summary list of each item of mechanical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.
- .3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.
- .4 Balancing and testing reports.
- .5 Copy of valve directory.
- .8 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to paragraph 3.2.5 and to Division 1 for requirements.
- .9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.
- .10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

1.6 QUALITY ASSURANCE

- .1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.
- .2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:
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|-----|--------|--|
| .1 | AABC | Associated Air Balance Council |
| .2 | AMCA | Air Moving and Conditioning Association |
| .3 | ANSI | American National Standards Institute |
| .4 | ASA | American Standards Association |
| .5 | ASHRAE | American Society of Heating, Refrigerating, and Air Conditioning Engineers |
| .6 | ASME | American Society of Mechanical Engineers |
| .7 | ASSE | American Society of Sanitary Engineers |
| .8 | ASPE | American Society of Plumbing Engineers |
| .9 | ASTM | American Society of Testing and Materials |
| .10 | AWWA | American Water Works Association |
| .11 | CAN2 | National Standard of Canada (Published by CGSB) |
| .12 | CAN3 | National Standard of Canada (Published by CSA) |
| .13 | CGSB | Canadian General Standards Board |
| .14 | CSA | Canadian Standards Association |
| .15 | EEMAC | Electrical & Electronic Manufacturer's Association of Canada |
| .16 | NBC | National Building Code of Canada |
| .17 | NEBB | National Environmental Balancing Bureau |
| .18 | NFPA | National Fire Protection Association |
| .19 | NEMA | National Electrical Manufacturers Association |
| .20 | OBC | Ontario Building Code |
| .21 | OFC | Ontario Fire Code |
| .22 | OFM | Ontario Fire Marshall |
| .23 | SMACNA | Sheet Metal & Air Conditioning Contractors National Association |
| .24 | TIAC | Thermal Insulation Association of Canada |
| .25 | ULC | Underwriter's Laboratories of Canada Ltd |
| .26 | UL | Underwriter's Laboratories (including cUL) |
- .3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.
- .4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.

- .5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.
- .6 All welding and brazing shall be executed by certified welders in accordance with registered procedures.
- .7 All refrigeration work shall be executed only by mechanics with valid ODP cards.

1.7 PRODUCT DELIVERY, HANDLING AND STORAGE

- .1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.
- .2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.8 JOB CONDITIONS

- .1 Visit site and examine existing conditions which may affect work of this Division.
- .2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
- .4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.9 INTERRUPTIONS

- .1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
- .2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
- .4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
- .5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.10 WARRANTY

- .1 Refer to Division 1 and to Section 25 01 01 General Requirements.
- .2 Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.
- .3 Make submissions necessary to register product warranties to the benefit of the Owner.
- .4 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

1.11 EXTRAS AND CREDITS

- .1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
 - .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
 - .2 Labour hours and unit costs.
 - .3 Total materials and labour costs.
 - .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.
- .2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.
- .3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.
- .4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 MOTOR STARTERS & CONTROLS

- .1 Mechanical Division shall provide all motor starters and associated controls required and as scheduled on drawings and noted for Mechanical Division equipment. Starters and controls shall be Canadian General Electric or Alternate noted. All starters, contactors, thermal overloads, etc. must be EEMAC rated. All starters shall be of one manufacturer except as specifically approved otherwise for integral pre-wired assemblies.
- .2 Starter and control units shall be equipped with necessary number of auxiliary contacts and relays to provide control sequences described in Mechanical Equipment Starter Schedule on Drawings. Auxiliary contacts shall be interchangeable normally open or normally closed, by conversion in field without additional parts exterior to starter.
- .3 Manual starters may only be provided for single phase equipment operated by control device such as thermostat or limit control when such control device is rated for full electrical load of equipment.
- .4 Manual starters provided for single phase equipment actuated by electric timer or shall have H.O.A. feature. "Hand" position shall permit shunting of time switch. Where such units also have protective device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" positions and shall not be shunted.
- .5 Manual starters may only be provided for three phase equipment which is not actuated by pilot control device (pressure switch, float switch, safety limit devices, remote manual control device) unless otherwise noted in Starter Schedule.
- .6 Magnetic starters for manually operated equipment shall have "On/Off" selector switch or "Start-Stop" pushbutton in cover as scheduled.
- .7 Magnetic starters which are started automatically by electric time switch shall include "Hand-Off-Automatic" (H.O.A.) selector switch. "Hand" position shall permit shunting of time switch or E.M.S. Where such units also have protective pilot device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" position and shall not be shunted.
- .8 Magnetic starters which are started automatically by remote pilot device (or interlocked units) such as level controller, pressure switch, thermostat or flow switch shall include "Hand-off-Auto" (H.O.A.) selector switch, and, where scheduled, a "Test" pushbutton. "Hand" position shall permit shunting of remote pilot device and thereby permit operation of starter but only while depressing "Test" button.
- .9 Equip starter apparatus for prime plumbing, heating, air conditioning and ventilating equipment so that these units will automatically restart on resumption of power after power outage. Starters for these units shall have "On/Off" selector switch in cover if not fitted with H.O.A. selector feature or manual starter or otherwise noted.
- .10 Safety control device such as flow switches, pressure switches, high and low limited ("Fire" and "Freeze") shall not be shunted by "Hand" position of switch.
- .11 Manual motor starter shall be toggle operated with following general construction features:
 - Quick-Make, Quick-Break mechanism with double-break contacts.
 - Overload protection heaters, one per phase and speed.

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- Enclosure to suit application.
 - Pilot light, neon lamp.
 - Cover engraved with "On-Trip-Off".
- .12 Magnetic motor starters shall comprise electrically-operated motor starters combined with disconnect switch with following general construction features:
- Quick-Make, Quick-Break mechanism with double-break contacts.
 - Fuse holders to accept specified fuses, one per phase.
 - Adjustable overload relays, one per phase.
 - CEMA listed enclosure to suit application. Disconnect with mechanical cover interlocks, line side barriers and switch operated electrical interlocks to disconnect external control voltage unless starter includes suitable approved enclosed contacts and connections.
 - "Reset" button.
 - Pilot Lights of transformer type incandescent with amber safety lens cap.
 - Control transformer with 120 volt fused secondary and sized to suit current rating of associated control devices.
 - Scheduled cover mounted control devices with standard duty double break contact blocks.
 - Minimum of two auxiliary contacts (unused "Seal-in" contact may be included).
- .13 Contactors for non-motor applications shall be built similar to combination magnetic starters, except less overload relays, and with Gould Shawmut AJT time delay HRC1-J fuses, rated for load, and with enclosed continuous current rating of at least 125% of connected full load.
- .14 "Double Voltage Relays" shall be CGE Model CR120 LXMC with general purpose enclosure, number of contacts required and "Mylar" shroud of enclosure of contacts, or approved equivalent.
- .15 Pilot devices such as "Start-Stop" pushbuttons, "Hand-Off-Auto" selector switches and indicating lights shall be of heavy-duty construction. Indicating lamps shall be transformer type incandescent with amber safety lens caps.
- .16 Each control unit shall be provided with engraved nameplates for designation of device controlled and duty. See Subsection "Equipment Markers & Nameplates" for details.
- .17 Control wiring shall be 120 volt A.C. maximum. Provide control circuit transformers where these are not included in motor starters. Secondaries of control transformers shall be fused with one side grounded and controls, safety devices and interlocks shall be connected in ungrounded conductor, excepting only integral starter overload devices.
- .18 Single phase motors interlocked to start or operate with other equipment shall be provided with magnetic starters or suitable relays with necessary auxiliary contacts and double voltage relays or be otherwise electrically separated.
- .19 Overload relay heaters for starters shall be selected and field adjusted to trip at maximum value of 115% of actual nameplate full load amperes. Selection of heater elements shall be based on starter manufacturer's recommendations. Obtain data from Mechanical Division. Submit Motor Starter Schedule which shall list following for each motor:
- Proposed equipment nameplate data
 - Actual full load amperes of motor
 - Speed of motor
 - Temperature Class in degrees Celsius rise and insulation class.
 - Circuit breaker or fuse type and proposed rating
 - Type of motor, duty and service factor.
- .20 Overload relay heaters shall trip in 20 seconds or less from cold or motor-locked rotar condition.
- .21 Where equipment is noted to be electrically interlocked, provide necessary interlocks, double voltage relays (Mylar shroud accepted) to provide specified operation.
- .22 Provide all fuses required to protect equipment. Fuses shall be proper size blade type time delay HRC1-J current limiting. Supply three spare fuses of each size and type and obtain duplicate receipt for same. Fuse clips shall reject standard NEC fuses. Fuses shall be rated in accordance with manufacturer's published data. Fuses to be of one manufacturer throughout.
- .23 Acceptable Alternate Manufacturers
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1. Furnas Electric
 2. Westinghouse
 3. Allen Bradley
 4. Square 'D'
 5. Cutler Hammer
 6. Klockner-Moeller.
 7. Commander
 8. Telemecanique

2.3 EQUIVALENTS AND ALTERNATIVES

- .1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.
- .2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.
- .3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to indicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

- .1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.
- .2 Apply, in writing, to Consultant for substitution of any products, indicating the following:
 - .1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
 - .2 Reason for substitution.
 - .3 Any revisions to the contract price made necessary by substitution.
 - .4 Any revisions to the contract time made necessary by substitution.
 - .5 Any revisions to layout, arrangement or services made necessary by substitution.
- .3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

- .1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.
- .2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract

Documents to reflect such changes.

3 Execution

3.1 RELATIONSHIP WITH OTHER TRADES

3.2 INSTALLATION REQUIREMENTS

- .1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
- .2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
- .3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
- .4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
- .5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
- .6 Provide suitable shielding and physical protection for devices.
- .7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
- .8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
- .9 Do not use powder activated tools except as permitted by the Prime Consultant and the Owner's workplace health and safety policies.
- .10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.3 CONTRACT DRAWINGS

- .1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
- .2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.
- .3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.
- .4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.
- .5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.
- .6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.
- .7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

3.4 CONSTRUCTION DRAWINGS

-
- .1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.
 - .2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.
 - .3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.
 - .4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.
 - .5 Submit construction drawings prior to commencement of work.

3.5 RECORD DRAWINGS

- .1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".
- .2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.
- .3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.
- .4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.
- .5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.
- .6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

3.6 USE OF EQUIPMENT

- .1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.
- .2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the edges are sealed so that the filters are not bypassed. Change the filters frequently, to the satisfaction of the Consultant, until the building is turned over the Owner.

3.7 SPECIAL TOOLS AND SPARE PARTS

- .1 Within 30 days of award of contract, prepare a complete itemized list of special tools and spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.
- .2 On completion of the project furnish spare parts to the Owner as follows:
 - .1 One set of mechanical seals for each pump.
 - .2 One casing joint gasket for each pump.
 - .3 One head gasket for each heat exchanger.
 - .4 One glass for each gauge glass installed.
 - .5 One set of v-belts for each piece of machinery.
 - .6 One set of new filters for each filter bank installed.

- .3 Identify spare parts containers as to contents and replacement parts number.
- .4 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

3.8 INSTRUCTION

- .1 Instruct and familiarize Owner's operating personnel with the various mechanical systems.
Arrange instruction for each system separately.
- .2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
- .3 Ensure each instruction period includes, but is not limited to the following;
 - .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
 - .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
 - .3 demonstration of the proper operating procedures for each item of equipment,
 - .4 explanation of the purpose and function of all safety devices provided,
 - .5 demonstration of all measures required for safe and proper access for operation and maintenance.
- .4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.
- .5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

3.9 START UP AND COMMISSIONING

- .1 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
- .2 The Startup and Commissioning Team shall be comprised of;
 - .1 The individual, company or agency undertaking the work of each Section,
 - .2 Representatives of the Contractor and his sub-contractors as required,
 - .3 Representatives of equipment manufacturers,
 - .4 Representatives of the Consultants,
 - .5 Representatives of the Owner.
- .4 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the startup and commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.
- .5 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.
- .6 Each Section shall prepare Check Sheets in accordance with the standards listed above and shall issue them to the commissioning team for use during the commissioning process.
- .7 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;
 - .1 name and logo of Facility,
 - .2 name of the project,
 - .3 the Owner's project number,
 - .4 identification of the system commissioned,
 - .5 the date that the system was commissioned.
- .8 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

End of Section

PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 1.

1.2 APPLICABLE STANDARDS

- .1 Applicable Standards are listed below:
 - .1 ASHRAE Standard 202-2024 - The Commissioning Process Requirements for New Buildings and New Systems
 - .2 ASHRAE Standard 230-2022 - Commissioning Process for Existing Buildings and Systems
 - .3 ASHRAE Guideline 0-2019 - the Commissioning Process
 - .4 ASHRAE Guideline 0.2-2015 - Commissioning Process for Existing Systems and Assemblies
 - .5 ASHRAE Guideline 1.1-2025 - Application of the Commissioning Process to New HVAC&R Systems
 - .6 ATSM E2813 – Standard Practice for Building Enclosure Commissioning
 - .7 ATSM E2947 – Standard Guide for Building Enclosure Commissioning
 - .8 CaGBC LEED v4.1 Building Design and Construction Reference Guide
 - .1 LEED EA p1: Fundamental Commissioning and Verification
 - .2 LEED EA c1: Option 1. Path 1: Enhanced Commissioning
 - .9 CSA Z320-11 Building Commissioning Standard & Check Sheets
 - .10 CSA C282-15 – Emergency Power Supply for Buildings
 - .11 NIBS Guideline 3-2012 – Building Enclosure Commissioning Process

1.3 GENERAL

- .1 The purpose of this section is to specify Division 25 responsibilities in the commissioning process.
- .2 Commissioning requires the participation of Division 25 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 25 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.4 SYSTEMS TO BE COMMISSIONED

- .1 Systems to be commissioned as part of this contract include, but may not be limited to the following:
 - .1 Building Automation System

1.5 COMMISSIONING TEAM

- .1 The Commissioning Team shall consist of representatives of the following as appropriate:
 - .1 Owner and the Owner's FM Staff

- .2 Consultant
- .3 Commissioning Authority (CxA)
- .4 General Contractor (GC)
- .5 Subcontractors (Mechanical, Electrical, Controls, TAB)
- .6 Specialized third-party for verification

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 COMMISSIONING AUTHORITY RESPONSIBILITIES

- .1 The Commissioning Authority shall:
 - .1 Plan, organize and implement the commissioning process as specified herein;
 - .2 Prepare the commissioning plan, ensure its distribution for review and comment;
 - .3 Revise the commissioning plan as required during construction;
 - .4 Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
 - .5 In conjunction with the GC, coordinate commissioning activities;
 - .6 Monitor system verification checks, and ensure the results are documented as the checks are done;
 - .7 Observe select start-ups and initial system operations tests and checks;
 - .8 Develop Functional Test scripts
 - .9 Direct the GC to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
 - .10 Witness functional performance tests and document the results;
 - .11 Prepare and submit a commissioning report which documents all checks and tests done throughout the commissioning process, and the results obtained from each;
 - .12 Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated facility operating staff.

3.2 CONSULTANT RESPONSIBILITIES

- .1 The Consultant commissioning responsibilities are outlined below:
 - .1 Review the commissioning plan, proposed test procedures, and participate (as appropriate) in on-site commissioning meetings.
 - .2 At their discretion during the acceptance phase of the commissioning process, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance

3.3 OWNER/ PROJECT MANAGER RESPONSIBILITIES

- .1 The Owner shall have the following commissioning responsibilities
 - .1 Ensure the availability of facility operations staff for all scheduled instructions and demonstration sessions (training).
 - .2 At their discretion, witness commissioning performance tests.

3.4 SUBCONTRACTOR RESPONSIBILITIES

- .1 The Contractor shall ensure that the Subcontractor complies with all requirements included in this Section and fulfills the following responsibilities during construction and acceptance phases in addition to those listed above are (all references apply to commissioned equipment only)
 - .1 Sequences of Operation Submittals. The Controls Subcontractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
 - .1 An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
 - .2 All interactions and interlocks with other systems.
 - .3 Detailed delineation of control between any packaged controls and the BAS, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 - .4 Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
 - .5 Start-up sequences.
 - .6 Warm-up mode sequences.
 - .7 Normal operating mode sequences.
 - .8 Unoccupied mode sequences.
 - .9 Shutdown sequences.
 - .10 Capacity control sequences and equipment staging.
 - .11 Temperature and pressure control: setbacks, setups, resets, etc.
 - .12 Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - .13 Effects of power or equipment failure with all standby component functions.
 - .14 Sequences for all alarms and emergency shut downs.
 - .15 Seasonal operational differences and recommendations.
 - .16 Initial setpoints and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
 - .17 Schedules, if known.

- .18 To facilitate referencing in testing procedures, all sequences shall be written in concise statements
- .2 Control Drawings Submittal
 - .1 The control drawings shall have a key to all abbreviations.
 - .2 The control drawings shall contain graphic schematic depictions of the systems and each component (i.e. sensors, dampers, coils, valves, etc.)
 - .3 The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
- .3 Provide a full points list with at least the following included for each point:
 - .1 Controlled system
 - .2 Point abbreviation
 - .3 Point description
 - .4 Display unit
 - .5 Control point or setpoint (Yes / No)
 - .6 Monitoring point (Yes / No)
 - .7 Intermediate point (Yes / No)
 - .8 Calculated point (Yes / No)
 - .9 Key:
 - .10 Point Description: DB temp, airflow, etc.
 - .11 Control or Setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
 - .12 Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
 - .13 Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
 - .14 Calculated Point: "Virtual" point generated from calculations of other point values.
- .4 The Controls Subcontractor shall keep the CxA informed of all changes to this list during programming and setup.
- .5 As-Built Controls Package - An updated as-built version of the Controls Drawings and Sequence of Operation, which is to include all items identified above, shall be provided to the CxA and included in the final controls O&M manual submittal.
- .6 Assist in TAB Work- The Controls Subcontractor shall assist in the TAB work through the following:
 - .1 Meet with the TAB subcontractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB Subcontractor any needed unique instruments for setting terminal unit boxes and instruct the TAB Subcontractor in their use (handheld control system interface for use around the building during TAB, etc.).

- .2 For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CxA prior to TAB.
- .3 Provide a qualified technician to operate the controls to assist the TAB subcontractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
- .7 Required assistance to the CxA - Assist and cooperate with the CxA in the following manner:
 - .1 Using a skilled technician who is familiar with the building, execute the functional testing of the all equipment specified in Section 01 91 00 under direction of the CxA. Provide two-way radios during the testing.
 - .2 Execute all control system trend logs specified in Section 01 91 00.
 - .3 Written Plan - The Controls Subcontractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing, according to the process in Section 01 91 00. At minimum, the plan shall include the following for each type of equipment controlled by the automatic controls:
 - .1 System name.
 - .2 List of devices.
 - .3 Step-by-step procedures for testing each controller after installation, including:
 - .4 Process of verifying proper hardware and wiring installation.
 - .5 Process of downloading programs to local controllers and verifying that they are addressed correctly.
 - .6 Process of performing operational checks of each controlled component.
 - .7 Plan and process for calibrating valve and damper actuators and all sensors.
 - .8 A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
 - .4 A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
 - .5 A description of the instrumentation required for testing.
 - .6 Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CxA and TAB subcontractor for this determination.
 - .7 Checkout Certification - Provide a signed and dated certification report to the CxA and GC upon completion of the checkout of each controlled device, equipment and system prior to functional testing. This report shall serve as confirmation that all system programming is complete in accordance to the Contract Documents, with the exception functional testing requirements. The checkout report shall also include complete point-to-point verification and sequence of operations verification checklists.
 - .8 List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).

3.5 SUBMITTALS

- .1 Division 25 Contractors shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 01 91 00 for additional Division 25 requirements.

3.6 START-UP OF EQUIPMENT

- .1 The GC shall ensure the Controls Subcontractor follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in Section 01 91 00, Part 3.10. Division 25 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA or Owner.
- .2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA, Consultant and GC. Beginning system testing before full completion does not relieve the Subcontractor from fully completing the system, including all pre functional checklists as soon as possible.
- .3 Prior to the start up of equipment the Division 25 Subcontractor shall arrange to have the Manufacturer of all major equipment inspect the installation to ensure their equipment has been installed in accordance with their recommendations.
- .4 The Supplier shall submit a written report of their findings.
- .5 Upon confirmation that the equipment has been installed in accordance with the Manufacturers Recommendations the equipment may be started.
- .6 All equipment shall be started by the Manufacturer's representative.

3.7 PRE-FUNCTIONAL TEST SHEETS

- .1 Pre-functional test sheets contain items for Division 25 Contractors to perform. On each checklist, a column is provided that is to be completed by the contractor assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.
- .2 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout. Items that do not apply should be noted along with the reasons on the form. If this form is not used for documenting, one of similar rigor and clarity shall be used pending approval from the CxA.

3.8 FUNCTIONAL TESTING, DOCUMENTATION, NON-CONFORMANCE AND ACCEPTANCE

- .1 Refer to Specification 01 91 00 for more information in addition to this 25 08 00.

3.9 OPERATION AND MAINTENANCE MANUALS

- .1 Division 25 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 25 and deliver to the GC for inclusion in the O&M manuals.
- .2 ASHRAE Guideline 4-2008 is the recommended format.

- .3 The CxA shall receive a copy of the O&M manuals for review.

3.10 TRAINING OF OWNER PERSONNEL

- .1 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 00 for additional details.
- .2 The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 00 for additional details.
- .3 The Controls Subcontractor shall have the following training responsibilities:
 - .1 Provide the CxA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.14.
 - .2 Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of the BAS system.
 - .3 Training shall start with classroom sessions, if necessary, followed by hands on training on the BAS, which shall illustrate the various modes of operation, including startup, 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 training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 - .6 Training shall include:
 - .1 Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - .2 Include a 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, shut-down, seasonal changeover and any emergency procedures.
 - .3 Discuss relevant health and safety issues and concerns.
 - .4 Discuss warranties and guarantees.
 - .5 Cover common troubleshooting problems and solutions.
 - .6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - .7 Discuss any peculiarities of equipment installation or operation.
 - .8 Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
- .4 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
- .5 The Controls Subcontractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.

- .6 Training shall occur after functional testing is complete, unless approved otherwise by the Consultant and/or Owner/Project Manager.

3.11 DEFERRED TESTING

- .1 Refer to Section 01 91 00, Part 3.15 for requirements of deferred testing.

3.12 WRITTEN WORK PRODUCTS

- .1 Written work products of Section 25 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets. Refer to Section 01 91 00 Part 3.16.

END OF SECTION

1 General

1.1 Conditions

- .1 Read and conform to:
 - .1 The General Conditions of the Contract as amended,
 - .2 The General Requirements of Division 1,

1.2 Building Management System Subcontractor

- .1 All work of this Section shall be coordinated and provided by a single BMS Subcontractor.
- .2 The work of this Section shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 15 Sections for details.
- .3 The work of this Section shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, warranties, services, and items which are required for the complete, fully functional and commissioned BMS, even if these are not specifically mentioned or fully described under this Section.
- .4 If the BMS subcontractor believes there are conflicts or missing information in the project documents, the subcontractor shall promptly request clarification and instruction from the design team.

1.3 General Description

- .1 Provide a complete control system for the Waterdown Fire Station facility. Include all programming, verification, start-up and training to deliver an operable system to the owner.
- .2 Provide a complete system including:
 - .1 Control Panel Including:
 - .1 Network Display Terminal
 - .2 Time Clock
 - .3 Run Status and Alarm lights for each AHU (total of 2 lights)
 - .2 AHU controllers
 - .3 VAV box controllers
 - .4 All Required Sensors and Devices
 - .5 Programming
 - .6 Site Testing/Verification
 - .7 Operator Training (4 hour) – Two training sessions of 2 hours each.
- .3 Provide electrical installation of the control panel and all associated devices.
- .4 Power for controls provided by others. Electrical division to provide 120 VAC power a local junction box near the VAV's. Controls contractor to provide power from junction box to the individual VAV controllers.
- .5 The control system shall use the BACnet protocol for communication to provide the capability of interacting with a Web based BAS in the future.
- .6 Provide and install dampers, damper actuators as shown on the contract documents. It is the responsibility of the controls contractor to size the damper actuators and submit the selection of the damper actuators to the consultant for approval before installation.
- .7 Provide and install a complete operating CO/NOX detection system:
GEM-11 Multipurpose, Self-contained Gas Detector
Dual Channel, Integral electrochemical carbon monoxide (CO) sensor(0-200 ppm range), integral electrochemical nitrogen dioxide (NO2) sensor (0-10 ppm range) LED indicators, 4-20 ma output, two 5A@240 VAC SPDT relays, audible alarm and silence push. The following accessories to be provided:
 - Splash guard, water /dust tight enclosure, LED digital display
 - TIB-2250M Enclosed external transformer, 120-22 VAC powered version.
 - RSH-24VDC Remote strobe & horn combo, 24VDC w/ckt & N1 housing.

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- SCS-8000-SPG Large galvanized metal protective guard 16 gauge.
 - Gas Detection system by Critical Environment Technologies and Honeywell are acceptable products.

- .8 All dampers in the project are to be provided by the controls contractor and are to be Tamco series 9000 thermally insulated, equivalent product by Ruskin is acceptable. All dampers to be installed by Mechanical contractor.

1.4 Acceptable BMS Subcontractors

- .1 The design of the controls system is HTS Engineering (416.661.3400).
- .2 The following Controls manufacturers are treated as equal:
- .1 Johnson Controls.
 - .2 Siemens Building Technologies Ltd.
 - .3 Honeywell Controls.
 - .4 Reliable Controls.

1.5 Warranty

- .1 Warrant work as follows:
- .1 Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

2 Products

2.1 Materials

- .1 Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 Communication

- .1 Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

2.3 Controllers

- .1 BACnet.
 - 1. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
- .2 Communication
 - 1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on
 - 2. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
- .3 Environment. Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

.4 Memory.

1. Controller memory shall support operating system, database, and programming requirements.
2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.

.5 VAV Controllers/Smart Actuators: Controllers to have integrated damper actuator and pressure sensor. Provide pre-loaded programs that are selectable via dip switches and allow for custom field programming.

.6 Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

.7 Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

.8 Network Display Terminals to come with 4 line LCD display and navigation buttons.

2.4 Auxiliary Control Devices

.1 Temperature Sensors.

1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
2. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.

.2 Relays.

1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from set point shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

.3 Pressure Transducers.

1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.

.4 Current Switches.

1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

.5 Local Control Panels.

1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
2. Provide Allen-Bradley (or equivalent) lights on panel.

2.5 Wiring and Raceways

- .1 General. Provide copper wiring, EMT conduit and metal flex as specified in applicable sections of Division 26.
- .2 Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

3. Execution

3.1 General Installation

- .1 Install all equipment, accessories, conduit and interconnecting wiring in a neat manner by a skilled and qualified person using the latest standard of practice for the industry.

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- .2 Unless otherwise specified meet manufacturer's latest printed instructions for materials, planned maintenance and installation methods.
 - .3 Notify consultant in writing of any conflict between these specifications and manufacturer's instructions.
 - .4 All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of equipment.
 - .5 Install equipment to allow for easy maintenance access. Ensure equipment does not interfere in any way with access to adjacent equipment and personal traffic in the surrounding space.
 - .6 Install all electrical wiring in conformance with the requirements of the local electrical authority, Provincial Building Code and, unless otherwise indicated, the specifications of Division 26 Electrical.
 - .7 Install low voltage wiring in accordance with the control manufacturer's recommendations. All wiring to be FT6 plenum rated cable where allowed by code. Provide EMT conduit where applicable.

3.2 Installation of Controlled Devices and Sensors

- .1 Install all equipment in accordance with manufacturer's published instructions.
- .2 Supply equipment to be installed by other divisions in accordance with their work schedule.
- .3 Coordinate final location of all sensors with consultant's field representative prior to installation.
- .4 Sensor assemblies and elements must be readily accessible.
- .5 Locate all sensing elements to correctly sense measured variable. Isolate elements from vibrations and temperatures which could affect measurement.

3.3 Acceptance and Testing Procedures

- .1 Controls contractor requests completion acceptance in writing and advises owner's authorized representative of situations that prevent a complete testing of overall system performance.
- .2 Return to the site to perform additional tests and/or adjustments, if required, to prove system performance during the warranty period.

3.4 Training

- .1 Provide 4 hours of training in two sessions for the operator at the completion of the project.

3.5 Warranty

- .1 All components, parts, and assemblies shall be guaranteed against defects in material and workmanship for a period of one (1) year after acceptance.

End of Section

1 General

1.1 General

- .1 Read and conform to:
 - .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended.
 - .2 Division 1 General Requirements.

1.2 SECTION INCLUDES

- .1 Sequence of operation:
 - .1 Heating system
 - .2 AHU
 - .3 VAV

2 Sequence of Operation

.1 Heating System

The system consists of modulating hot water boilers and heating pumps with the VFD. The boilers are equipped with original manufacturer safeties and manufacturer recommended safeties. The boiler safeties have higher priority and BAS should not override any safeties. Boiler plants shall be enabled during all the heating season from September 1st to May 31st. During Summer months, June, July, and August the boiler plant remains off.

1. Heating Pump (P1, P2)

The lead pump is enabled to run continuously when the system is enabled. The differential pressure and pump status shall be monitored. Minimum differential pressure value will be set up during balancing and will be adjustable. The lead pump speed shall be modulated to maintain system differential pressure set point. Lead pump assignment shall be rotated weekly, contractor shall coordinate scheduling requirements with building owner.

2. Hot water supply temperature

The supply setpoint shall be 60°C (140°F) (adj.) when the outside air temperature is 15.5°C (60°F) (adj.).

3. Boilers (B-1, B-2)

The lead hot water boiler shall be enabled to run when the hot water system is enabled, and the lead pump status has been confirmed, and the system hot water supply temperature is less than set point. The hot water boilers shall modulate and be staged in sequence to maintain the system hot water supply temperature to set point. On failure of a boiler, as indicated by an alarm, the boiler shall be locked out. The next sequenced boiler shall take over operation. On alarm reset, the failed boiler shall return to service.

4. Hot Water flow

A magnetic flow meter and bypass control valve shall be installed in the hot water system. Exact location to be determined on site with Owner.

Magnetic flow meter shall monitor the return water flow to ensure boilers are provided with manufacturers recommended minimum flow rate.

Heating waster system bypass valve to be modulated to maintain the minimum required flow rate.

5. Emergency Shut-Off Switch

New boiler emergency shut-off switches shall be hard-wire interlocked to all boilers and gas fired hot water tanks in the boiler room. Upon activation of switch, all boilers and hot water tanks shall immediately be disabled.

6. Monitoring

The following data points shall be monitored:

- .1 Hot Water Boilers B-1, B-2:
 - .1 Supply Water Temperature
 - .2 Burner Status
 - .3 Common Alarm
 - .4 Local/Remote Switch Status
- .2 Common Hot Water Supply and Return Temperature
- .3 Hot Water Return Temperature from each zone

7. Critical Alarms

- .1 The lead boiler (B-1) is enabled, and status is not received (2-minute delay).
- .2 Low temperature limit.
- .3 Low leaving water temperature.

.2 Hot Water Unit Heater

- .1 Unit is enabled and disabled to maintain space air temperature to set point, initially set to 22°C (adjustable) during occupied period, and 18°C (adjustable) during unoccupied period.

.3 Radiation & Terminal Reheat Zones

Heating setpoints shall be limited to a reasonable range minimum and maximum setpoint are adjustable at the ows within hard code limits of 20 - 23°C setpoint adjustment is identified only as "w - c" for "warmer - cooler" control valve modulates the flow through the wall fin or reheat coil to maintain space temperature at setpoint, as determined by thermostat mounted in the spaces.

Night setback of heating shall be implemented with a setback temperature of 15°C (adjustable at ows either globally or zone by zone within a reasonable range of 12 - 20°C)

During the setback period, occupants may override the setback for two hours by pushing the "override" button on the thermostat. The stat shall acknowledge the override by means of a red led which shall first flash for a few seconds and then burn continuously until the override period times out. Override period is adjustable at ows, either globally or zone by zone, within hard coded limits of 30 to 300 minutes

.4 Zones without Radiation

BAS modulates flow through two or three way reheat valves to maintain room temperature at setpoint. Setpoint is adjustable within a reasonable range.

Some zones have plate type temperature sensors, without mode override. Setpoints for these zones is adjustable within a reasonable range, at ows only.

BAS implements night setback of heating setpoint with override led on stat is "on" when zone is in override mode.

.5 Rooftop unit

- .1 The rooftop unit serves the space VAV boxes. Unit consists of a supply fan, exhaust fan, mixing dampers, DX cooling, gas heating and hydronic reheat coils.
- .2 The unit is a variable volume unit and the supply and exhaust fans have been provided with variable frequency drives.
- .3 The unit will provide both cooling and heating to the VAV boxes. Heating and cooling modes are shared with

-
- the VAV box controllers. The supply air temperature from the Roof Top Units will be set at 55 deg F.
- .4 During cooling season the VAV boxes will modulate to maintain space temperature at set point.
 - .5 During heating season the reheat coils will modulate to maintain the room temperature at set point. BAS will maintain 55 deg F supply air temperature at the unit level.
 - .6 Humidifier will operate during winter to maintain the room RH level at set point (50% RH).
- .2 Safeties and Limits
- .1 The DDC controller will shutdown and lockout the unit if the supply air temperature drops below 4 Deg C when the unit is running. Note logic is not applied during the first 5 minutes of operation. Once shutdown the operator must correct the problem and manually restart the unit through the LCD. Low temperature protection will only work when the fans are being controlled by the DDC controller. If the fan is in hand there will be no low temperature protection.
 - .2 A high static pressure limit is hardwired to shut down the supply and return fans when the sensed pressure is above setpoint. Manual reset is required.
 - .3 Fan speed modulation is disabled until fan run status is received.
 - .4 Supply air temperature control is disabled until fan run status is received.
 - .5 Damper control is disabled until fan run status is received.
 - .6 If the supply air temperature rises above 135 Deg F (57 Deg C) the controller will shutdown the unit and issue an alarm. Manual reset through the LCD is required.
 - .7 If the return air temperature rises above 135 Deg F (57 Deg C) the controller will shutdown the unit and issue an alarm. Manual reset through the LCD is required.
 - .8 DX cooling is locked out when the outdoor air temperature is below 10 Deg C.
 - .9 Simultaneous heating and cooling is not permitted.
 - .10 The fire alarm system is hardwired to the fan VFD (by others) and will shutdown the unit in the event of an alarm.
- .3 Modes of Operation
- .1 The occupied and unoccupied modes of operation are determined by a time clock. System can be set to run continuously in the occupied mode.
 - .2 The pre-cool mode is utilized to pre-cool the space during the summer to conserve energy. When seasonally enabled (manually by operator through LCD) the pre-cool mode will be activated when:
 - 1. The outdoor air temperature is between 10 Deg C and 22 Deg C.
 - 2. The average space temperature is more than 2 Deg C above the outdoor air temperature and is also above 18 Deg C.
 - .3 The pre-cool mode is disabled once the average space temperature is within 1 Deg C of the outdoor air temperature or reaches 18 Deg C.
 - .4 The disabled mode is manually set by the operator.
- .4 Start Up/Shutdown
- .1 The supply fan starts.
 - .2 At start up the initial static pressure setpoint will be set to 375 Pa.
 - .3 At start up the initial supply air temperature setpoint will be either: 1) Set to 15 Deg C or 2) Set to 27 Deg C if the unit is starting on morning warm up, 3) Set to 13 Deg C if the unit is starting on morning cool down.
- .5 Occupied Mode
- .1 The rooftop unit runs continuously. Supply fan speed is controlled to maintain the supply air static pressure at setpoint. Setpoint is reset between a minimum of 190 Pa to a maximum of 437 Pa based on feedback from the zones. Setpoint will be reset based on the number of requests received. When 2 requests are received the setpoint will increase by 10 Pa every 5 minutes. When 4 or more requests are received the setpoint will increase by 20 Pa every 5 minutes. When no requests are received the setpoint will be decreased by 10 Pa every 15 minutes.
 - .2 The unit is controlled to maintain the supply air temperature at setpoint. Setpoint will be based and the setpoint reset will be based on the mode (heating or cooling). The heating mode is set when the outdoor air temperature drops below 5 Deg C, the cooling mode is set when the outdoor air temperature rises above 20 Deg C. When the outdoor air temperature is in between it will be set by the last mode of operation or can be manually set by an operator.
 - .3 In the heating mode the following will occur:

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1. The supply air temperature setpoint will be reset between 12 Deg C and 15 Deg C based on feedback from the zones. Reheat coil in the zones will modulated to maintain the zone temperature at set point.
 - .4 In the cooling mode the following will occur:
 1. The supply air temperature setpoint will be reset between 13 Deg C and 23 Deg C based on feedback from the zones. When a cooling request is received the setpoint will decrease 1 Deg C every 10 minutes. When no cooling requests are received the setpoint will be increased 0.5 Deg C every 10 minutes.
 - .5 The dampers will be positioned to provide minimum fresh air to the space. When free cooling is available and required and available the dampers will modulate to provide additional fresh air for free cooling purposes. Free cooling will be the first stage of cooling. Free cooling will be available when the outdoor air temperature is more than 2.5 Deg C below the return air temperature. The exhaust damper will be controlled with the fresh air damper. When the damper is open above 30% the exhaust fan will be enabled. It's speed will increase linearly as the fresh air damper opens.
 - .6 DX cooling and gas heating are controlled to maintain the supply air temperature at setpoint.
 - .7 Pressure sensor to be installed at 2/3rd of the duct run to modulate the supply and return fan. Location of the sensor to be determined on site.
 - .8 Bas to install pressure sensors to maintain the building pressure at neutral with respect to the outdoors.
 - .6 Unoccupied Mode
 - .1 The rooftop unit is off.
 - .2 The fresh air and exhaust air dampers are closed. The return air damper is open.
 - .7 Pre-Cool Mode
 - .1 Unit will operate as per the occupied mode with the following exceptions:
 1. Minimum fresh air volume is set to 0 cfm.
 2. The supply air temperature setpoint will be set to 15 Deg C.
 3. No mechanical cooling or heating is permitted. Mode is used to pre-cool spaces.
 - .8 Disabled Mode
 - .1 The rooftop unit is off.
 - .2 The fresh air and exhaust air dampers are closed. The return air damper is open.
 - .9 Integration with Other Systems
 - .1 Outside air temperature is shared over the network.
 - .2 Air requests are received from the network.
 - .3 Cooling requests are received from the network.
 - .4 Heating requests are received from the network.
 - .10 Critical Alarms
 - .1 Fan is commanded on and status is not received (2 minute delay).
 - .2 Low temperature limit.
 - .3 High supply air temperature shutdown.
 - .4 High return air temperature shutdown.
 - .11 General Alarms
 - .1 The supply air temperature drops below 7 Deg C.
 - .2 The supply air temperature rises above 43 Deg C.
 - .12 Maintenance Alarms
 - .1 Fan is commanded off and status is on (10 minute delay).
 - .13 Trends
 - .1 Supply air temperature and setpoint.
 - .2 Outside air temperature.
 - .3 Return air temperature.
 - .4 Mixed air temperature.
 - .5 Supply air static pressure and setpoint.
 - .6 Fan status.

.5 Typical VAV/ Box

.1 General

- .1 The VAV box provides cooling, heating and ventilation to the space.
- .2 The mode of operation (heating or cooling) is provided by the air handling unit.
- .3 Reheat coil control valve is modulated to maintain zone temperature set point during winter.

.2 Modes of Operation

- .1 The occupied and unoccupied modes are determined by a time-of-day schedule.
- .2 The purge mode is activated set when the following is true:
 - .1 The system is in unoccupied mode.
 - .2 The outdoor air temperature is above 10 Deg C and below 24 Deg C.

.3 Occupied Mode

- .1 The VAV controller reads in velocity pressure and converts this information to an airflow value.
- .2 The controller will modulate the damper to maintain the airflow value at setpoint. Minimum and maximum airflow setpoints are shown on the VAV box schedule. The box is equipped with both cooling mode and heating mode airflow setpoint.
- .3 The VAV controller will increase/decrease the airflow setpoint to maintain the space temperature at setpoint.
- .4 When the AHU is in the cooling mode the VAV box will increase its airflow setpoint to provide additional cooling to the space. When the rooftop unit is in the heating mode the VAV box will increase its airflow setpoint to provide additional heating to the space.
- .5 The space temperature setpoint will be set to 22 Deg C heating and 24 Deg C cooling. Setpoints are operator adjustable.
- .6 During heating season, the reheat coil modulates to maintain the zone temperature at set point.

.4 Unoccupied Mode

If the AHU is still running the box will control as per the occupied mode with the following exceptions:

- .1 Minimum airflow setpoint will be set to unoccupied setting.
- .2 Supply air set point during heating season will be set to 12°C and the cooling setpoint will be set to 27°C.
- .3 If the rooftop unit is off the VAV box damper will be open.
- .4 Reheat coil will modulate to maintain 18°C during the unoccupied period.

.5 Pre-Cool Mode

The box will control as per the unoccupied mode with the following exceptions:

- .1 The cooling setpoint will be set to 18°C.
- .2 The minimum cooling airflow setpoints will be reduced to 5% of the maximum cooling airflow setpoint.
- .3 The minimum and maximum heating airflow setpoints will be set to 5% of the maximum heating airflow setpoint.

.6 Washroom and Storage Exhaust Fans

The washroom and storage fans shall be energized based on time of the day schedule. BAS monitors the status of each fan. The BAS generates an alarm if the fan does not start when commanded.

.7 CO/NOx Ventilation

The respective exhaust fans of the apparatus bay will operate with the outdoor air damper to maintain the

CO/NOx set point as read by the CO/NOx sensor. If the set point is not reached upon activation of the system for a pre-determined time, then the system generates an audible and visible alarm. The CO/NOx Set point will be determined during system start up.

.8 IR Heaters

BAS will turn on the IR heaters based on corresponding thermostat setpoint in the apparatus bay.

.9 Furnace

BAS average heating/cooling requirements and send heating/cooling command to furnace/air conditioning which has terminal control. Display each zone temperature on BAS graphic.

BAS controller dry contact provides 24VAC signal to furnace terminal strips to enable fan on/off, 1st stage heating and 2nd stage heating. BAS controller dry contact provides 24VAC signal to air conditioning unit terminal strips to enable 1st stage cooling and 2nd stage cooling. The initial 24VAC signal comes from furnace terminal strips – “R”. BAS determines furnace/air conditioning idle, fan only, cooling and heating.

Temperature sensors on main supply/return air duct, display sensors’ reading on BAS graphic, current sensors for furnace blower motor and air conditioning unit, display current reading on BAS graphic.

.10 Split A/c Unit

Based on the temperature reading the unit will turn on/ off by BAS

.11 Electric Baseboard, FFH

Based on the time of the day schedule, BAS will turn on/off the units.

.12 ERV

BAS shall turn on/ off , high low speed based on the input from the temperature and CO2 sensors from thermostats.

End of Section

Electrical Specifications
Whitchurch-Stouffville Fire Station & York Region
EMS
Issued for 100% Review
13^h June 2025

DIVISION 26: COMMON REQUIREMENTS FOR ELECTRICAL

- | | |
|----------------------|--|
| 1. Section 26 05 00 | Electrical Work General Instructions |
| 2. Section 26 05 05 | Basic Electrical Materials and Methods |
| 3. Section 26 05 06 | Seismic Control and Restraint |
| 4. Section 26 05 07 | Fire Stopping and Smoke Seal System |
| 5. Section 26 05 09 | Electrical Work Testing |
| 6. Section 26 05 10 | Mounting Heights |
| 7. Section 26 05 21 | Conductors (0-1000 Volts) |
| 8. Section 26 05 28 | Grounding and Bonding |
| 9. Section 26 05 31 | Splitters, Junction and Pull Boxes |
| 10. Section 26 05 32 | Outlet Boxes, Conduit Boxes and Fittings |
| 11. Section 26 05 34 | Conduit Systems |
| 12. Section 26 05 37 | Wireways and Auxiliary Gutters |
| 13. Section 26 05 40 | Wiring Devices |
| 14. Section 26 09 23 | Occupancy Sensors |
| 15. Section 26 24 01 | Service Entrance Equipment |
| 16. Section 26 24 16 | Distribution Panelboards |
| 17. Section 26 24 18 | Branch Circuit Panelboards |
| 18. Section 26 28 18 | Ground Fault Protection Equipment |
| 19. Section 26 32 13 | Diesel Generator |
| 20. Section 26 36 23 | Automatic Transfer Switch |
| 21. Section 26 50 10 | Building Interior Lighting |
| 22. Section 26 50 15 | Building Exterior Lighting |
| 23. Section 26 52 00 | Emergency Lighting |
| 24. Section 26 53 00 | Exit Lighting |

DIVISION 27: COMMUNICATIONS

- | | |
|----------------------|--|
| 25. Section 27 05 00 | Grounding & Bonding for Communication Systems |
| 26. Section 27 05 28 | Pathways for Communication Systems |
| 27. Section 27 05 53 | Identifications for Communications Systems |
| 28. Section 27 08 00 | Commissioning of Communications Systems |
| 29. Section 27 11 00 | Communications Equipment Room Fittings |
| 30. Section 27 11 19 | Terminal Blocks, Patch Panels & Connectors |
| 31. Section 27 15 00 | Horizontal Cabling |
| 32. Section 27 16 00 | Communications connecting cords devices and adapters |

DIVISION 28: ELECTRONIC SAFETY AND COMMUNITY

- | | |
|----------------------|-----------------------------|
| 33. Section 28 13 00 | Access Control |
| 34. Section 28 13 10 | Fire Alarm Systems |
| 35. Section 28 20 00 | Portable Fire Extinguishers |

End of Section

1 GENERAL**1.01 REFERENCES**

- .1 The General Conditions of the Contract, the Supplementary Conditions, and all Sections of Division 01 apply to and are a part of this Section of the Specification.

1.02 APPLICATION

- .1 This Section specifies requirements that are common to electrical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.03 NOTE RE: BOLD LETTERING

- .1 "**Bold**" type lettering is used throughout this Specification in an attempt to enhance the readability of the text. The use of "**bold**" lettering does not indicate a greater level of importance.

1.04 SUBMITTALS

- .1 As specified in this Section, submit the following to the Consultant:
 - .1 **project close-out documentation:** O & M Manuals, record as-built drawings, and all associated data.
 - .2 **progress payment breakdown:** a detailed breakdown of the electrical work cost
 - .3 **Extended Warranties:** copies of all extended warranties specified and shall be in the name of the Owner.
 - .4 **O & M Training Schedules & Manual:** a proposed schedule of demonstration and training dates and times, and a preliminary copy of the training manual developed for operational and maintenance training.

1.05 DEFINITIONS

- .1 The following are definitions of words found in electrical work Sections of the Specification and on associated drawings:
 - .1 "concealed" – means work hidden from normal sight in furred spaces, shafts, tunnels, ceiling spaces, walls and partitions
 - .2 "exposed" – means work normally visible, including work in electrical and equipment rooms and similar spaces
 - .3 "provide" (and tenses of provide) – means supply and install complete
 - .4 "install" (and tenses of install) – means install and connect complete
 - .5 "supply" – means supply only

- 6 "finished area" - means any area or part of an area which receives a finish such as paint, or is factory finished
- .7 "governing authority" and/or "regulatory authority" and/or "Municipal authority" – means all government departments, agencies, standards, rules and regulations that apply to and govern the electrical work and to which the work must adhere
- .8 "Consultant" – means the Architect or Consulting Engineer who has prepared the Contract Documents on behalf of the Owner
- .2 Wherever the words "indicated", "shown", "noted", "listed", or similar words or phrases are used in the specification they are understood, unless otherwise defined, to mean that the product referred to is "indicated", "shown", "listed", or "noted" on the drawings.
- .3 Wherever the words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected" or similar words or phrases are used in the specification or on the drawings they are understood, unless otherwise defined, to mean that work or product referred to is "approved by", "inspected by", etc., the Consultant.
- .4 In the electrical specification, singular may be read as plural, and vice-versa.

1.06 QUALITY ASSURANCE

- .1 All electrical work is to be done by journeyman tradesmen who perform only the work that their certificates permit, or by apprentice tradesmen under direct on-site supervision of an experienced journeyman tradesman. The use of apprentice tradesmen is to be limited and the journeyman/apprentice ratio is subject to the Consultant's approval.
- .2 An experienced and qualified superintendent is to be on-site at all times when electrical work is being performed.

1.07 CODES, REGULATIONS, AND STANDARDS

- .1 All Codes, Regulations, and Standards referred to in this Section and in Sections to which this Section applies are the latest edition of the Codes, Regulations, and Standards in effect at the time of bidding on this Project.
- .2 All electrical items are to be certified and bear the stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.
- .3 Requirements of the Contract Documents are to take precedence when they are more stringent than codes, ordinances, standards, and statutes.

1.08 IMPERIAL AND METRIC MEASUREMENTS

- .1 Conform to requirements of CAN/CSA-Z234.1, Canadian Metric Practice Guide.
- .2 Both Metric and Imperial units of measurement are indicated in the electrical Specification. Metric measurements are "soft" and have been rounded off.

1.09 EXAMINATION OF SITE AND DOCUMENTS

- .1 When estimating the cost of the work and prior to submitting a bid for the work carefully examine all of the bid documents and visit the site to determine and review all existing site conditions that will or may affect the work and include for all such conditions in the bid price.
- .2 Report to the Consultant, prior to bid submittal, any existing site condition that will or may affect performance of the work as per the drawings and specifications. Failure to do so will not be grounds for additional costs.

1.10 DRAWINGS AND SPECIFICATION

- .1 Read the electrical work drawings in conjunction with all other structural, architectural, sprinkler, mechanical, etc., drawings.
- .2 The electrical drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of the building are to be taken at the site. Do not scale the drawings, and do not use the drawings for prefabrication work.
- .3 The drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, all offsets, fittings, transformations, and similar products required as a result of obstructions and other architectural and structural details but not shown on the drawings.
- .4 The locations of equipment and materials shown may be altered, when reviewed by the Consultant, to meet requirements of the equipment and/or materials, other equipment or systems being installed, and of the building, all at your cost.
- .5 Sections of the electrical specification are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and the Sections are to be read as a whole.
- .6 The electrical specification does not generally indicate the specific number of items or extent of material required. The specification is intended to provide product data and installation requirements. It is necessary to refer to drawing schedules, layouts, schematic diagrams, riser diagrams, and details to determine correct quantities.
- .7 The electrical drawings and specification are intended to be cooperative. Perform all work that is shown, specified, or reasonably implied on the drawings but not mentioned in the specification, or vice-versa, as though fully covered by both.
- .8 When the scale and date of the drawings are the same, or when the discrepancy exists within the specification, the most costly arrangement will take precedence.
- .9 In the case of discrepancies or conflicts between the drawings and specification, the documents will govern in the following order:
 - .1 the specification
 - .2 drawings of larger scale

- .3 drawings of smaller scale
- .4 drawings of later date when the scale of the drawings is the same.
- .10 In the case of discrepancies between the drawings and specifications, the documents will govern in the order specified in the General Conditions, however, when the scale and date of the drawings are the same, or where the discrepancy exists within the specification, the costliest arrangement will take precedence.

1.11 PLANNING AND LAYOUT OF THE WORK, AND ASSOCIATED DRAWINGS

- .1 Properly plan, coordinate, and establish the locations and routing of services with all subcontractors affected prior to installation such that the services will clear each other as well as any obstructions, including structural components of the building. Unless otherwise specified, the order of right-of-way for services is to be as follows:
 - .1 piping requiring uniform pitch
 - .2 piping 100 mm (4") dia. and larger
 - .3 large ducts (main runs)
 - .4 electrical cable tray and bus duct
 - .5 conduit 100 mm (4") dia. and larger
 - .6 piping less than 100 mm (4") diameter
 - .7 smaller branch ductwork
 - .8 conduit less than 100 mm (4") diameter
- .2 Unless otherwise shown or specified, conceal all work in finished areas, and conceal work in partially finished or unfinished areas to the extent made possible by the area construction. Install conduit, raceway, and similar services as high as possible to conserve headroom and/or ceiling space. Notify the Consultant where headroom or ceiling space appears to be inadequate prior to installation of the work.
- .3 Revise or alter the arrangement of work that has been installed without proper coordination, study and review, even if it was completed in accordance with the Contract Documents, in order to conceal the work behind finishes, or to allow the installation of other work, at no additional cost. In addition, pay for the cost of alterations in other work required by the alterations to your work.
- .4 All junction boxes, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.

1.12 COORDINATION OF THE WORK

- .1 Review all the Contract Documents and coordinate the work with the work of all subcontractors. Coordination requirements are to include, but not be limited to, the following:

- .1 written notifications of all concrete work such as housekeeping pads, bases, etc., required for electrical work, and including required dimensions, operating weight of equipment, location, etc.
- .2 depth and routing of excavation required for electrical work, and requirements for bedding and backfill

1.13 GENERAL RE: INSTALLATION OF EQUIPMENT

- .1 Unless otherwise specified all equipment is to be installed in accordance with the equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.
- .2 Ensure that proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Remove and replace any equipment which does not meet this requirement.

1.14 PERMITS, FEES, AND CERTIFICATES

- .1 Apply for, obtain and pay for all permits required to complete the electrical work.
- .2 Submit to the Consultant, all approval/inspection certificates issued by governing authorities to confirm that the work as installed is in accordance with the rules and regulations of the governing authorities. Pay any costs associated with issue of the certificates.
- .3 Include a copy of all approval/inspection certificates in each operating and maintenance manual.

1.15 WORKPLACE SAFETY

- .1 Comply with requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding the use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for all products where required, and maintain one copy at the site in a visible and accessible location available to all personnel.
- .2 Comply with all requirements of Occupational Health and Safety Regulations and all other regulations pertaining to health and safety, including worker's compensation/ insurance board and fall protection regulations.

1.16 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Prior to supplying any products to the site, submit for review, shop drawings and/or product data sheets indicating in detail the design, construction, and performance of products as requested in Sections of this Specification. The number of copies of shop drawings and/or product data sheets will be as later directed.
- .2 Shop drawings are those prepared specifically for the Project. Product data sheets are copies of manufacturer's standard catalogue, etc., literature.
- .3 Unless otherwise specified or required, submit shop drawings/product data sheets via email in

AutoCAD or PDF format only.

- .4 Wherever possible, shop drawings and/or product data sheets are to be digital electronic PDF format; 215 mm x 280 mm (8½" x 11"), 215 mm x 356 mm (8½" x 14"), or 356 mm x 432 mm (11" x 17") single side white bond paper with sufficient clear space for review stamps, comments, and identification as specified below.
- .5 Shop drawings and product data sheets must confirm that the product proposed meets all requirements of the Contract Documents.
- .6 Each shop drawing or product data sheet is to be properly identified with the project name and the product drawing or specification reference, i.e. "Lighting Fixture F1", and all shop drawing or product data sheet dimensions are to be either SI or Imperial to match dimensions on the drawings.
- .7 Carefully review each shop drawing and product data sheet prior to submittal to ensure that the proposed product is correct and meets with all requirements of the Project. Endorse each copy of each shop drawing or product data sheet "Correct for Review By Consultant", or "Certified to Be In Accordance With All Requirements" and include your company name, the submittal date, and the signature of an officer of your company to indicate your review and approval as above.
- .8 The Consultant will review shop drawings and product data sheets and will indicate the review status by stamping the shop drawings and product data sheets as follows:
 - .1 **"Reviewed" or "Reviewed As Noted"** to indicate that his review is final and no re- submittal is required
 - .2 **"Returned For Correction"** to indicate that the submission is rejected and is to be revised in accordance with comments marked on the shop drawings and product data sheets by the Consultant and re-submitted
- .9 The Consultant will retain one digital electronic PDF copy of each shop drawing or product data sheet submission. Copy of shop drawings in digital and hard copy format shall be kept on site for the duration of the construction.
- .10 The following is to be read in conjunction with the wording on the Consultant's review stamp applied to each and every electrical work shop drawing or product data sheet submitted:

"This review is for the sole purpose of ascertaining conformance with the general design concept. This review does not approve the detail design inherent in the product data/shop drawings, responsibility for which remains with the Contractor, and such review does not relieve the Contractor of the responsibility for errors or omissions in the product data/shop drawings or of his responsibility for meeting all requirements of the Contract Documents. Be responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for coordination of the work of all sub-trades."

1.17 N I L (NOT IN LIST)

1.18 SCAFFOLDING, RIGGING, AND HOISTING

- .1 Unless otherwise specified or directed, supply, erect and operate all scaffolding, rigging, hoisting

equipment and associated hardware required for your work. Immediately remove from the site all scaffolding, rigging, and hoisting equipment when no longer required.

1.19 PROJECT CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance, submit all required items and documentation specified, including the following:
 - .1 Operating and Maintenance Manuals
 - .2 as-built record drawings and associated data.
 - .3 extended warranties for equipment as specified.
 - .4 all operating test certificates, i.e. Fire Alarm System Test Certificate.
 - .5 identified keys for electrical equipment and/or panels for which keys are required, and all other items required to be submitted.
 - .6 other data or products specified.
- .2 **Operating and Maintenance Manuals:** Submit (2) two hard copies and (1) one digital electronic PDF of operating and maintenance manuals consolidated in hardcover three "D" ring binders, each binder sized to include approximately 25% spare space for future data, and identified permanently with the Project name, "ELECTRICAL OPERATING AND MAINTENANCE MANUAL" wording, and the date. Manuals are to include the following:
 - .1 an Introduction sheet listing the Consultant's, Contractor's, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses.
 - .2 a Table of Contents sheet, and corresponding index tab sheets
 - .3 a copy of each "Reviewed" or "Reviewed As Noted" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, and the email address for local source of parts and service
 - .4 test reports, and certificates issued by governing authorities.
 - .5 **Operating Data:** Operating data is to include:
 - .1 a description of each system and its controls
 - .2 operation instruction for each system and each component
 - .3 description of actions to be taken in event of emergencies and/or equipment failure
 - .6 **Maintenance Data:** Maintenance data is to include:
 - .1 servicing maintenance, operation and trouble-shooting instructions for each item of equipment and each system
 - .2 schedules of tasks, frequency, tools required, and estimated task time.

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- .3 complete parts list with numbers
 - .7 **Performance Data:** Performance data is to include:
 - .1 equipment and system start-up data sheets
 - .2 equipment performance verification test results, and final commissioning report
 - .8 **Review Submittal:** Assemble one copy of the O & M Manual and submit to the Consultant for review prior to Owner training and instructions and assembling the remaining copies. Incorporate all comments into the final submission.
 - .9 **Digital O & M Manuals:** Submit four digital versions of the hard copy manual using the latest version of Adobe Acrobat Portable Document Format and enhanced with bookmarks, internet links, and internal document links. The digital copies are to be copied to CDR with custom labels which indicate the project name, date, the Consultant's name, and "Operating & Maintenance Manual for Electrical Systems".
 - .3 **Record "As-Built" Drawings and Data:** As work progresses at the site, clearly mark in red in a neat and legible manner on a set of white prints of the Contract Drawings, all significant changes and deviations from the routing of services and locations of equipment shown on the Contract Drawings and resulting from the issue of Addenda, Site Instructions, Change Orders, and job conditions. Use notes marked in red as required. Maintain the white print red line as-built set at the site for the exclusive use of recording as-built conditions, keep the set up-to-date at all times, and ensure that the set is always available for periodic review. The as-built set is also to include the following:
 - .1 the dimensioned location of all inaccessible concealed work
 - .2 the locations of control devices with identification for each
 - .3 the location of all junction boxes, terminal cabinets, etc.
 - .4 for underground conduit, ducts, etc., record dimensions, invert elevations, all offsets, fittings, and accessories if applicable, and locate dimensions from benchmarks that will be preserved after construction is complete.
 - .5 the location of all concealed services terminated for future extension.
 - .6 **Digital Record "As-Built" Drawings:** When work on site is complete, transfer all the as-built red line information from the site as-built drawings to a recordable and identified CAD disc with CAD work of equal quality to the Contract Drawings. Obtain a CAD disc as described below.
 - .7 **Obtaining CAD Discs:** The electrical drawings have been prepared on a CAD system using the latest Release of AutoCad software. For the purpose of producing final as-built drawings, discs of the Contract Drawings will be supplied free of charge by the Consultant.
 - .8 **Review and Submittal:** Prior to inspection for Substantial Performance of the work, submit for review, the red line site as-built white prints, a CAD disc of the as-built drawings, and a bound set of white prints (of equal quality to the Contract Drawings) made from the disc. The Consultant

will review the drawings and, if necessary, return the disc and the marked-up white prints for corrections or further revisions, in which case complete the corrective and/or revision work and resubmit the disc and white prints until they are determined to be acceptable, all prior to issue of a Certificate of Substantial Performance.

1.20 (NOT IN LIST)**1.21 (NOT IN LIST)****1.22 EXTENDED WARRANTIES**

- .1 Unless otherwise specified, all extended warranties specified in electrical work Sections of the Specification are to be full parts and labour warranties, at the site, and in accordance with requirements of the Contract warranty, but direct from the equipment manufacturer/supplier to the Owner. Submit signed and dated copies of extended warranties which clearly state requirements specified above.

1.23 EQUIPMENT AND MATERIAL MANUFACTURER REQUIREMENTS

- .1 Equipment and materials scheduled or specified on the drawings or in the Specification have been selected to establish a performance and quality standard.
- .2 In most cases acceptable equipment and material manufacturers are listed for any product specified by manufacturer's name and model number. Unless otherwise stated the bid price may be based on products supplied by any of the manufacturers or an approved equivalent named as acceptable for the particular product. If acceptable manufacturers are not listed for a particular product, base the bid price on the products supplied by the specified manufacturers or an approved equivalent.
- .3 If products supplied by a manufacturer named as acceptable or approved equivalent are used in lieu of the products specified by manufacturer's name and model number, ensure that the product is equivalent in performance and operating characteristics (including energy efficiency if applicable) to the specified product. Pay for any additional costs and changes to associated or adjacent work resulting from the use of products supplied by a manufacturer other than the specified manufacturer. In addition, in equipment spaces where products named as acceptable are used in lieu of the specified products and the dimensions of such products differ from the specified products prepare and submit for review, if requested, accurately dimensioned layouts of the rooms affected to prove that all the equipment in the room will fit properly.

1.24 LIST OF ACCEPTABLE MANUFACTURERS AND SUPPLIERS

- .1 At the contract kick-off meeting after award of a Contract, submit to the Consultant for review, a list to indicate the name of the manufacturers/suppliers you propose to use for each item of equipment, material, or service listed, except for items such as conduit, branch circuit conductors, and similar products. Manufacturers and/or suppliers on the list must be named in the Specification or on the drawings.
- .2 If the List of Acceptable Manufacturers and Suppliers is not submitted at the contract kick-off meeting

after award of a Contract, the products specified and scheduled by manufacturer's name and model number and on which the Project is based are to be supplied. No substitutions whatsoever will be accepted unless previously approved in writing by the Consultant.
General Contractor can provide list of approved equivalent equipment which meets the specifications.

1.25 (NOT IN LIST)**1.26 (NOT IN LIST)****1.27 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION**

- .1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for the equipment/system manufacturer's authorized representative to visit the site to examine the installation, and when any required corrective measures have been made, to certify in writing to the Consultant that the equipment/system installation is complete and in accordance with the equipment/system manufacturer's instructions.

1.28 EQUIPMENT AND SYSTEM START-UP

- .1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in electrical work Sections in accordance with the following requirements:
 - .1 submit a copy of each equipment/system manufacturer's start-up report sheet to the Consultant for review, and incorporate any comments.
 - .2 under direct on-site supervision and involvement of the equipment/system manufacturer's representative, start-up the equipment/systems, make any required adjustments, document the procedures, leave the equipment/systems in proper operating condition, and submit a complete set of start-up documentation sheets signed by the manufacturer/supplier and the Contractor.

1.29 EQUIPMENT AND SYSTEM COMMISSIONING

- .1 After successful start-up and prior to Substantial Performance, commission the electrical work using approved commissioning sheets. Submit final commissioning data sheets. Include for equipment manufacturer's representation at the site to assist in the commissioning process.

1.30 EQUIPMENT AND SYSTEM O & M DEMONSTRATION & TRAINING

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
- .2 Train the Owner's designated personnel in all aspects of operation and maintenance of equipment and systems as specified in electrical work Sections of the Specification. All demonstrations and training is to be performed by qualified technicians employed by the equipment/system manufacturer/supplier.
- .3 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Operating and Maintenance Manuals are to be used during the training sessions, and training modules are to include:

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- .1 **Operational Requirements and Criteria:** requirements and criteria are to include but not be

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- limited to equipment function, stopping and starting, safeties, operating standards, operating characteristics, and limitations.
- .2 **Troubleshooting:** troubleshooting is to include but not be limited to diagnostic instructions, test and inspection procedures.
 - .3 **Documentation:** documentation is to include but not be limited to equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like
 - .4 **Maintenance:** maintenance requirements are to include but not be limited to inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools.
 - .5 **Repairs:** repair requirements are to include but not be limited to diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- .4 Assemble the training modules into a training manual and submit a copy to the Consultant for review prior to scheduling training. Ensure that each participant in each training session has all required training material.
 - .5 Schedule demonstrations and training at mutually agreed to times with a minimum of 7 working days notice.
 - .6 **Demonstration and Training Confirmation:** Obtain a list of personnel to receive demonstration and training from the Consultant, and have each participant sign the list to confirm that he/she understood the demonstration and training session.

End of Section

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies products, common criteria and characteristics, and methods and execution that are common to one or more electrical work Sections of the Specification, and it is intended as a supplement to each Section and is to be read accordingly.

1.02 SUBMITTALS

- .1 Submit the following for review:
 - .1 **product data sheets:** submit for:
 - .1 firestopping and smoke seal products
 - .2 waterproofing seal assemblies
 - .3 electrical work identification products
 - .2 **access door locations:** submit white prints of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations in walls and ceilings in finished areas
 - .3 **samples:** submit a sample of each proposed type of access door, and samples of materials and any other items as specified in electrical work Sections of the Specification
 - .4 **list of equipment nameplates:** submit a list of equipment identification nameplates indicating proposed wording and sizes
 - .5 **conduit & conductor identification:** submit a list of conduit and conductor identification colour coding and wording
 - .6 **sleeve and formed opening location drawings:** submit, prior to concrete pours, accurately dimensioned drawings to locate all required sleeves, formed openings, and recesses required in poured concrete
 - .7 **waste management and reduction plan:** submit a waste management and reduction plan prior to commencing work and as per requirements specified in this Section
 - .8 **additional submittals:** submit any other submittals specified in this Section or other electrical work Sections of the Specification

2 PRODUCTS

2.01 SLEEVES

- .1 **Galvanized Sheet Steel:** Minimum #16 gauge galvanized steel with an integral flange at one end to secure the sleeve to formwork construction.
- .2 **Polyethylene:** Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
- .3 **Waterproof Sleeves:** Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at the sleeve midpoint, or PSI-Thunderline "Century-Line" Model CS HDPE sleeves or approved equivalent.
- .4 **Galvanized Steel:** Schedule 40 mild galvanized steel.

2.02 MULTI-CABLE TRANSITS

- .1 UL/ULC listed and labelled multi-cable transits sized to suit the fire barrier opening and the number of cables/conduits involved and to facilitate a minimum 2 hour water-tight fire and smoke seal. Each assembly is to be complete with a stainless steel frame, cadmium plated compression bolts, proper end packing, compression plates, steel stay plates, and fire rated neoprene insert blocks.

2.03 FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Firestopping and smoke seal system materials for electrical penetrations through fire rated construction are specified in the electrical work Section entitled Firestopping and Smoke Seal Systems and the work is to be done as part of the electrical work.

2.04 WATERPROOFING SEAL MATERIALS

- .1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so that when the bolts are tightened the links expand to seal the opening watertight. The seal assemblies are to be selected to suit the pipe size and the sleeve size or wall opening size. Acceptable products are as listed below or approved equivalent.
 - .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;
 - .2 The Metraflex Co. "MetraSeal" type ES.

2.05 ESCUTCHEON PLATES

- .1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to the building surface, each plate sized to completely cover the conduit/cable sleeve or building surface opening, and to fit tightly around the conduit or cable.

2.06 ACCESS DOORS

- .1 Prime coat painted steel (unless otherwise specified) flush access doors, each complete with a minimum #16 gauge frame, minimum #18 gauge door panel, heavy-duty rust-resistant concealed hinges, a positive locking screwdriver lock, and mounting and finishing features to suit the particular construction in which it is to be installed.
- .2 Access door sizes are to suit the concealed work for which they are supplied, and wherever possible they are to be of a standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.
- .3 Access doors in fire rated construction are to be ULC listed and labelled and of a rating to maintain the fire separation integrity.
- .4 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting the finish in which they are to be installed so as to maintain the final building surface appearance throughout, and constructed of stainless steel with a #4 finish.

2.07 IDENTIFICATION MATERIALS

- .1 **Equipment Nameplates:** Minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as single phase starters and switches, minimum 25 mm x 65 mm (1" x 2½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:
 - .1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved capital letter wording to completely identify the equipment and its use with no abbreviations;
 - .2 wording is generally to be as per the drawings, i.e. Lighting Panel A, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;
 - .3 supply stainless steel screws for securing nameplates in place
 - .4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level
- .2 **Self-Adhesive Labels:** Equal to Brother "P-Touch" or Thomas & Betts Canada Ltd. "EZCODE" Model EZL500 electronic labelling system self-adhesive labels with size and colour as directed, and permanently printed circuit identification nomenclature which is to be approved by the Consultant prior to producing the labels.
- .3 **Warning Signs:** Equal to Thomas & Betts Canada Ltd. "BP" Series 250 mm x 355 mm (10" x 14") semi-rigid vinyl signs with corner screw holes, the required printed wording (generally red on a white background with black trim), pressure sensitive adhesive on

the back, and stainless steel screws.

- .4 **Conduit and Armoured Cable Identification:** Equal to Brady Canada minimum 50 mm (2") wide self-adhesive coloured vinyl tape.
- .5 **Conductor Terminations:** Equal to Electrovert Ltd. Slip-on "Z" type
- .6 **Conductor Colour Coding:** As specified with the conductors.

2.08 ELECTRICAL ENCLOSURES

- .1 Unless otherwise specified electrical enclosure are to be wall mounting NEMA/EEMAC/CSA enclosures as follows:
 - .1 indoor in sprinkler protected areas, Type 2
 - .2 indoor in high humidity/washdown areas, Type 4
 - .3 indoor in corrosive environments, Type 4X, 316 stainless steel
 - .4 indoor explosion-proof, Class 1, Groups C & D, Type 7
 - .5 outdoor, Type 3R
 - .6 indoor in non-hazardous areas except as noted above, Type 1

2.09 ENCLOSURE BACKBOARDS

- .1 Construction grade Fir plywood, G1S, 20 mm ($\frac{3}{4}$ ") thick with width and length to suit enclosure dimensions, coated on all surfaces with a ULC listed water based latex intumescent flame retardant paint, ASTM E-84 Class A rated.

3 EXECUTION

3.01 GENERAL ELECTRICAL WORK INSTALLATION REQUIREMENTS

- .1 Unless otherwise specified, locate and arrange horizontal conduits, raceways, and conductors above or at the ceiling on floors on which they are shown, arranged so that under consideration of all other work in the area, the maximum ceiling height and/or usable space is maintained.
- .2 Unless otherwise specified, install all conduits and conductors concealed in finished spaces, and concealed to the degree possible in partially finished and unfinished spaces. Refer to and examine the Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Note that walls which are painted are considered finished.
- .3 Unless otherwise specified conduits and main distribution conductors may be exposed in equipment rooms.
- .4 Install all exposed conduits, raceways, and conductors parallel to building lines and to each other.

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- .5 Do not install conduit, raceway, or conductors within 150 mm (6") of "hot" piping or equipment.
 - .6 All conduit, raceway, conductors, etc., must be supported from the structure, not from ceiling hangers, piping, ductwork, cable tray, and similar mechanical or electrical products.
 - .7 Neatly group and arrange all exposed work. Do not install conduit to prevent access into equipment.
 - .8 **Access:** Locate all work to permit easy access for service or maintenance as required and/or applicable. Locate all products which will or may need maintenance or repairs and which are installed in accessible construction so as to be easily accessible from access doors. Where such products occur in vertical services in shafts, pipe spaces or partitions, locate the accessories at the floor level.
 - .9 **Manufacturer's Instructions:** Ensure that equipment and material manufacturer's installation instructions are followed unless otherwise specified herein or on the drawings, and unless such instructions contradict governing codes and regulations.
 - .10 **Cleaning:** Carefully clean all conduits, raceway, fittings prior to installation. Temporarily cap or plug ends of conduit which are open and exposed during construction.
 - .11 **Surfaces To Receive Your Work:** Inspect surfaces and structure prepared by other trades before performing your work. Verify that surfaces or the structure to receive your work have no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of your work will constitute acceptance of such surfaces as being satisfactory.
 - .12 **Repair of Finished Surfaces:** For factory applied finishes, repaint or refinish all surfaces damaged during shipment and installation. The quality of the repair work is to match the original finish. This requirement also applies to galvanized finishes.
 - .13 **Work In High Humidity Areas:** Where electrical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on the products to protect against corrosion or provide products which will not corrode in the environment.
 - .14 **Work In Health Care Facility Patient Care Areas:** Provide conduit, conductors, and similar work in health care facility patient care areas in accordance with the Ontario Electrical Safety Code, including amendments, and test branch circuits in accordance with CAN/CSA Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

3.02 INSTALLATION OF SLEEVES

- .1 Where conduits, round ducts, and armoured cable pass through concrete and/or masonry surfaces provide sleeves as follows:

- .1 **in poured concrete slabs:** unless otherwise specified - minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves
- .2 **in concrete or masonry walls:** Schedule 40 galvanized steel pipe
- .2 **Waterproof Sleeves:** Provide waterproof sleeves in the following locations:
 - .1 in mechanical room floor slabs, except where on grade
 - .2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets
 - .3 in all floors equipped with waterproof membranes.
 - .4 in the roof slab
 - .5 in waterproof walls
- .3 Size sleeves, unless otherwise specified, to leave 12 mm ($\frac{1}{2}$ ") clearance around the conduit, duct, cable, etc.
- .4 Pack and seal the void between the sleeves and the conduit, duct, cable, etc., in non-fire rated construction for the length of the sleeves as follows:
 - .1 **interior construction:** pack sleeves in interior construction with mineral wool and seal both ends of the sleeves with non-hardening silicone base caulking compound
 - .2 **exterior walls above grade:** pack sleeves in exterior walls above grade with mineral wool and seal both ends of the sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified
 - .3 **exterior walls below grade:** seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified below.
- .5 Where sleeves are required in masonry work, accurately locate and mark the sleeve location, and hand the sleeves to the mason for installation.
- .6 Terminate sleeves that will be exposed so that the sleeve is flush at both ends with the building surface concerned so that the sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 100 mm (4") above the finished floor.
- .7 "Gang" type sleeving will not be permitted.
- .8 Where sleeves are provided in non-fire rated construction for future services, or where conduit, ducts, cable, etc., has been removed from existing sleeves, cap and seal both ends of the sleeved opening.

3.03 RECTANGULAR OPENINGS

- .1 Rectangular openings for cable tray, raceways, multiple conduits and/or cables and similar rectangular openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by the trade responsible for the particular construction in which the opening is required.
- .2 **Waterproof Openings:** Provide watertight link type mechanical seals in exterior wall openings where shown or specified. Assemble and install each mechanical seal in accordance with the manufacturer's instructions. After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until the seal is completely watertight.
- .3 **Openings In Non-Fire Rated Construction:** For all rectangular openings in non-fire rated construction pack and seal the space between the conduits, ducts, cables, etc., with mineral wool for the full thickness of the building surface penetrated, and seal both ends.
- .4 **Openings In Fire Rated Construction:** Provide multi-cable transits in all fire rated openings and install in accordance with the manufacturer's instructions.

3.04 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

- .1 Prepare and submit for review, white print drawings indicating the size and location of all required sleeves, recesses and formed openings in poured or precast concrete work.
- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.05 INSTALLATION OF ESCUTCHEON PLATES

- .1 Provide escutcheon plates suitable secured over all exposed conduits, ducts, armoured cable, etc., passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.
- .2 Install the plates so that they are tight against the building surface concerned, and ensure that the plates completely cover sleeves and/or openings, except where waterproof sleeves extend above floors, in which case the plate is to fit tightly around the sleeve.

3.06 INSTALLATION OF FASTENING AND SECURING HARDWARE

- .1 Provide fastening and securing hardware required for electrical work to maintain installations attached to the structure or to finished floors, pads, walls, and ceilings in a secure and rigid manner capable of withstanding the dead loads, live loads, superimposed dead loads, and any vibration of the installed products.

- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where floor, wall, or ceiling construction is not suitable to support the loads, provide additional framing or special fasteners to ensure proper securement to the structure. Provide reinforcing or connecting supports where required to distribute loading to structural components.
- .4 Obtain written consent before using explosive actuated fastening devices. If consent is given comply with requirements of CAN3-Z166.1 and .2.
- .5 Do not attach fasteners to steel deck without written consent from the Consultant.

3.07 SUPPLY OF ACCESS DOORS

- .1 Supply access doors to give access to all electrical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on the drawings.
- .2 Locate access doors as inconspicuously as possible in walls and partitions and arrange electrical work such that it is clearly within view and accessible for inspection and servicing, and to suit access door locations shown on the reviewed and approved white prints of reflected ceiling plan and elevation drawings submitted as per Part 1 of this Section.
- .3 Group services to ensure the minimum number of access doors is required. Access doors will be installed by the trades responsible for the particular type of construction in which the doors are required.
- .4 Submit a sample of each proposed access door for review prior to ordering.

3.08 ELECTRICAL WORK IDENTIFICATION

- .1 Identify all new/relocated electrical work in accordance with existing identification standards at the site.
- .2 Identify all electrical work, including conduit systems and wiring, as follows:
 - .1 the size and wording of identification nameplates must be approved by the Consultant
 - .2 identification wording for equipment is to follow drawing nomenclature unless otherwise specified
 - .3 secure nameplates to equipment with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces
 - .4 locate nameplates in the most conspicuous and readable location

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- .5 for multi-cell or multiple component equipment provide a main nameplate and a smaller nameplate for each cell or component
 - .6 where electrical work is to be identified in conjunction with mechanical work, coordinate with the mechanical trades to ensure identical tagging
 - .7 all identification wording is to be in English
 - .8 all identification and colour coding is to be indicated on "as-built" record drawings
 - .2 **Terminal Cabinets, Pull Boxes, Junction Boxes, Etc.:** Clearly identify terminal cabinets, main pull and junction boxes by neatly spray painting the outside surface of the cover with a paint colour as specified below for conduit and conductor identification. Provide a nameplate on terminal boxes, main pull and junction boxes in communication systems specified in Division 27.
 - .3 **Transformers:** Transformer nameplate must identify the transformer capacity as well as primary and secondary voltages.
 - .4 **Branch Circuit Panelboards:** Panelboard nameplates must identify the electrical source connected to the panelboard, each circuit breaker, and, neatly typed on the door directory card, the load connected to each breaker.
 - .5 **Motor Starters and Disconnect Switches:** Provide nameplates for each motor starter and disconnect located in a motor control centre or on a motor starter panel, and on each individually mounted starter and disconnect provided as part of the electrical work. Nameplates must also indicate the voltage and phase.
 - .6 **Luminaires On Emergency Circuits:** Identify all luminaires on emergency circuit by means of a 15 mm (½") diameter self-adhesive red label secured to the T-bar ceiling component adjacent to the luminaire, or if not in a T-bar ceiling, to the frame of the luminaire.
 - .7 **Lighting Switches & Receptacles:** Identify each lighting switch and each receptacle by means of a permanent self-adhesive label indicating the source panelboard and circuit number and secured to the device faceplate.
 - .8 **Communication Equipment/Systems:** Identify all "head end" equipment with nameplates and all "downstream" devices with self-adhesive labels indicating circuit numbers.
 - .9 **Warning Signs:** Provide appropriately worded warning signs secured in place with stainless steel hardware in locations as follows:
 - .1 on all doors into transformer vaults
 - .2 on all doors into high voltage switchgear rooms
 - .3 on all collector bus enclosures
 - .4 on pad mounted transformer enclosures

.5 wherever else required by Code

- .10 **Conduit & Armoured Cable:** Colour code conduit and armoured cable by means of 25 mm (1") wide primary colour plastic adhesive backed tape or neatly applied suitable paint with, where scheduled, a 20 mm (¾") wide auxiliary colour at all points where the conduit or cable penetrates a wall, ceiling, floor, at 6 m (20') intervals or at least once in each room or accessible ceiling space, at each access door location, and elsewhere at 15 m (45') intervals. Unless otherwise indicated/specified, colours are to be as follows:

Service	Primary Colour	Secondary Colour
up to 250 volts	yellow	
250 to & including 600 volts	yellow	green
above 600 volts to 5 kV	yellow	blue
above 5 kV to 28 kV	yellow	red
telephone	green	
fire alarm	red	
emergency voice	red	blue
security systems	red	yellow
other communication systems	green	
isolated power	orange	

- .11 **Wire & Cable Terminations:** Identify both end of wire and cable terminations with the same unique number. Where numbers are not indicated or specified, assign a number and record them.
- .12 **Buried Cable/Duct Runs:** Identify buried cable/duct runs under paved and landscaped areas with appropriate concrete markers, flush with grade at each change in direction, at least twice on runs less than 60 m (200') and on 60 m (200') centres on longer runs.
- .13 **Overhead Wiring Service Poles:** Unless otherwise indicated on the drawings identify poles with wording such as "HV#1". For wooden poles use 50 mm (2") high non-corrosive embossed aluminium pole markers. For concrete poles use non-corrosive metal plated secured to the pole with metal strapping.
- .14 **Health Care Patient Care Area Circuits:** For dedicated circuits provide identification as previously specified plus engraved "Dedicated Circuit" nameplates on the device faceplate, or provide faceplates with "Dedicated Circuit" engraved wording. For 20 ampere corridor housekeeping receptacles provide "20A Housekeeping" nameplates on the device faceplate.
- .15 **Distribution System Schematic Diagrams:** Prepare AutoCAD, coloured, 1200 mm x 900 mm (48" x 36") schematic diagrams of electrical distribution systems to identify all equipment and circuits. Install framed and glazed diagrams in electrical rooms housing the system equipment. Confirm location prior to installation. Include reduced size copies of the diagrams in each copy of the O & M Manuals.

3.09 INSTALLATION OF TERMINAL BACKBOARDS

- .1 Provide properly sized plywood backboards for wiring terminals in terminal cabinets and enclosures where shown/specified/required.

3.10 GENERAL ELECTRICAL WORK TESTING

- .1 Perform testing in accordance with the Electrical Work Testing Section, and, in addition, any tests required by governing Codes, Standards.

3.11 BRANCH CIRCUIT BALANCING

- .1 Connect all branch circuits to panelboards so as to balance the actual loads (wattage) to within 5%. If required, transpose branch circuits to achieve this requirement.
- .2 After the building is occupied and if requested by the Consultant, demonstrate that branch circuit balancing has been achieved.

3.12 FINISH PAINTING OF ELECTRICAL WORK

- .1 Finish paint exposed electrical work as specified and/or scheduled in accordance with requirements of the painting Section in Division 09.
- .2 Touch-up paint all damaged factory applied finishes on electrical work products.
- .3 Finish painting of exposed electrical work is specified in Division 09 and is part of the work of Division 09.

3.13 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

- .1 Motor starters for mechanical equipment will be supplied as part of the mechanical work.

3.14 ELECTRICAL WIRING WORK FOR MECHANICAL WORK

- .1 Unless otherwise specified or indicated, the following electrical wiring work for mechanical equipment is to be done as part of the electrical work:
 - .1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from the starters or disconnects to the equipment
 - .2 mounting of individual starters, "line" side power wiring to individual wall mounted starters, and "load" side wiring from the starters to the equipment
 - .3 "line" side power wiring to pre-wired power and control panels and variable frequency drives, and "load" side power wiring from the panels and VFD's to the equipment
 - .4 provision of receptacles for plug-in equipment
 - .5 provision of disconnect switches for all motors that are in excess of 10 m (30') from the starter location, or that cannot be seen from the starter location, and all associated power wiring
 - .6 all motor starter interlocking in excess of 24 volts

- .7 wiring from motor winding thermistors in motors 30 HP and larger to motor starter contacts
- .8 provision of dedicated 120 volt, 15A-1P circuits terminated in junction boxes in mechanical equipment rooms for automatic control and building automation system wiring connections to be made as part of the automatic controls work
- .9 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers;
- .10 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units
- .11 120 volt wiring connections to duplex receptacles integral with air handling unit control panels
- .2 Mechanical wiring work not listed above or specified herein or on the drawings will be done as part of the mechanical work in accordance with wiring requirements specified for the electrical work.

3.15 EQUIPMENT BASES AND SUPPORTS

- .1 **Concrete Housekeeping Pads:** Unless otherwise specified or required, set all floor mounted equipment on minimum 100 mm (4") high reinforced concrete housekeeping pads 200 mm (8") clear of the equipment on each side and end, or a minimum of 200 mm (8") from the centreline of equipment anchor bolts to the edge of the base, whichever is larger. Conform to the following requirements:
 - .1 supply dimensioned drawings and equipment base templates, and provide anchor bolts for proper setting and securing of equipment on pads
 - .2 place anchor bolts during the concrete pour and be responsible for all required levelling, alignment, and grouting of the equipment
 - .3 as a minimum, use wire mesh reinforcement, however, for pads for large heavy equipment, use reinforcement as per structural drawing details
- .2 **Structural Steel Stands/Supports:** For equipment not designed for base mounting, where required, provide welded, cleaned and prime coat painted structural steel stands or supports conforming to the following requirements:
 - .1 all stands and supports, except those for small equipment, are to be designed by a structural engineer registered in the jurisdiction of the work, and stamped and signed design drawings with calculations are to be submitted as shop drawings for review
 - .2 all steel stands are to be flange bolted to concrete housekeeping pads
 - .3 all stands and supports are to be seismically restrained in accordance with applicable requirements

3.16 CONCRETE WORK FOR EQUIPMENT BASES/PADS

- .1 Provide all poured concrete work, including reinforcing and formwork, required for electrical equipment bases/pads. Perform concrete work in accordance with requirements specified in Division

03.

- .2 Concrete is to be minimum 20,700 kPa ready-mix concrete in accordance with CAN/CSA- A23.1 and the Building Code.
- .3 Ensure that bases and pads are keyed into the structure to meet seismic restraint requirements.

3.17 EXCAVATION AND BACKFILL WORK

- .1 Do all excavation, backfill and related work required for your work. Perform such work in accordance with requirements of the Excavation and Backfill Section, except as modified by this Article. Obtain a copy of the soil test report and review during the bidding period.
- .2 Grade the bottom of trench excavations as required.
- .3 In firm, undisturbed soil, lay ducts, conduits, etc., directly on the soil, unless otherwise directed.
- .4 Unless otherwise specified, backfill trenches within the building with clean sharp sand in individual layers of maximum 150 mm (6") thickness compacted to a density of 100% Standard Proctor. Hand compact the first layers up to a compacted level of minimum 300 mm (12") above the top of the service. Hand or machine compact the balance up to grade.
- .5 Unless otherwise specified, backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") thick above the service, hand compacted to a density of 95% Standard Proctor, using granular "A" gravel. Backfill the balance in 150 mm (6") layers with approved excavated material, compacted to 95% Standard Proctor density.
- .6 Unless otherwise specified, backfill trenches outside the building under roads, parking lots or traffic areas with crushed stone or granular "A" gravel in layers not exceeding 150 mm (6") thickness, compacted to 100% Standard Proctor density up to grade level.
- .7 The location and inverts of existing underground site services shown on the drawings are based on available information and are assumed to be correct, however, prior to excavation, carefully check inverts and locations and report any serious discrepancy, and contact Utilities to accurately locate their services.
- .8 You will be held responsible for any damage done to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.
- .9 After the first lift of backfill has been compacted, mark the entire path of pipe using continuous 75 mm (3") wide detectable identified marking tape equal to SMS Ltd. D- UGMT.
- .10 Engage the services of an independent soils testing agency to test the final backfill compaction density of each backfilled location. Compact the backfill to the satisfaction of the testing agency and in accordance with the Specification. Submit a copy of the testing agency's report to the Consultant for review.

3.18 CUTTING, DRILLING, AND PATCHING

- .1 Do all cutting, drilling and patching of the existing building for the installation of your work.

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- Perform all cutting and drilling with proper tools and equipment. Confirm the exact location of cutting and drilling with the Consultant prior to commencing the cutting and/or drilling work.
- .2 Patch surfaces, where required, to exactly match existing finishes using tradesmen skilled in the particular trade or application worked on.
 - .3 Where new conduits, conductors, etc., pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around the product involved.
 - .4 Prior to drilling or cutting an opening in poured concrete construction, determine the location, if any, of existing services concealed in the construction to be drilled or cut. X- ray or Ferro Scan Test the walls or slabs if required.
 - .5 You will be responsible for the repair of any damage to existing services, exposed or concealed, caused as a result of your cutting or drilling work.
 - .6 Where drilling is required in waterproof slabs, size the opening to permit snug and tight installation of a sleeve which is sized to leave 12 mm (½") clearance around the product involved. Provide a sleeve in the opening. Sleeves are to be Schedule 40 galvanized steel pipe with a flange at one end and a length to extend 100 mm (4") above the slab. Secure the flange to the underside of the slab and caulk the void between the sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water- tight installation.

3.19 PACKING AND SEALING CORE DRILLED OPENINGS

- .1 Pack and seal the void between the core drilled opening and the service insulation for the length of the opening as follows:
 - .1 **non-fire rated interior construction:** pack openings in non-fire rated interior construction with mineral wool and seal both ends of the opening with non-hardening silicone base caulking compound to produce a water-tight seal;
 - .2 **exterior walls above grade:** pack sleeves in exterior walls above grade with mineral wool and seal both ends of the sleeves water-tight with approved non- hardening silicone base caulking compound unless mechanical type seals have been specified;
 - .3 **exterior walls below grade:** seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified below.

3.20 FLASHING FOR ELECTRICAL WORK PENETRATING THE ROOF

- .1 Do all required flashing work, including counter-flashing, for electrical work penetrating and/or set in the roof.
- .2 Perform flashing work in accordance with requirements of drawing details, and requirements specified in Division 07.

3.21 CLEANING ELECTRICAL WORK

- .1 Refer to cleaning requirements specified in Division 01.
- .2 Clean **all** electrical work prior to application for Substantial Performance of the work.

3.22 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE

- .1 Maintain all equipment in accordance with the manufacturer's printed instructions prior to start-up, testing and commissioning.

3.23 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with requirements specified in Division 01.
- .2 Separate and recycle waste materials in accordance with requirements of Canadian Construction Association Standard Document CCA 81, A Best Practices Guide to Solid Waste Reduction.
- .3 Prepare a waste management and reduction plan and submit a copy for review prior to work commencing at the site.
- .4 Place materials defined as hazardous or toxic waste in designated containers.
- .5 Ensure emptied containers are sealed and stored safely for disposal.

3.24 SEISMIC RESTRAINT ANCHOR POINTS FOR EQUIPMENT

- .1 All electrical equipment requiring seismic restraint (see the electrical work Section entitled Seismic Control and Restraint) is to be complete with manufacturer designed and rated seismic restraint anchor points and attachments, certified by the equipment manufacturers, so that the equipment may be bolted down or restrained in the field.
- .2 The equipment to be restrained must be designed such that the strength and anchorage of the internal components of the equipment exceeds the force level used to restrain and anchor the equipment itself to the supporting structure.

3.25 REQUIREMENTS FOR BARRIER-FREE ACCESS

- .1 Include for all applicable requirements for barrier-free access to electrical devices in accordance with governing Codes and Regulations, whether shown on the drawings, specified, or not

End of Section

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies seismic control and restraint requirements that are common to electrical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.02 SEISMIC CONSULTANT

- .1 Retain and pay for the services of an experienced Seismic Consultant who is a registered professional engineer licensed in the area of the work and a member in good standing of a Professional Engineers Association in the area of the work.
- .2 The Seismic Consultant is to:
 - .1 determine the proper seismic hazard level, design, recommend, and review all proposed electrical work seismic restraint shop, placement and securing drawings, and sign and stamp all drawings prior to submittal for review as specified below
 - .2 supervise installation of all electrical work seismic restraint and, when work is complete, certify in writing that the seismic restraint work has been installed in accordance with signed, stamped and reviewed drawings
 - .3 prepare and submit to the Municipality and authorities having jurisdiction, on a form approved by the Municipality and authorities having jurisdiction, at the beginning of seismic restraint work and when the work is complete, original signed and sealed Letters of Assurance for the design, installation and field review of all seismic restraint work

1.03 SUBMITTALS

- .1 **Shop Drawings/Product Data Sheets:** Obtain all required equipment information and submit manufacturer's shop drawings/product data sheets for all restraining devices and steel bases. Include placement data, and details of attachment to both the equipment and the structure meeting requirements of the forces involved. All product data sheets and drawings are to be signed and stamped by the Seismic Consultant referred to above.
- .2 **Seismic Consultant's/Seismic Control Product Manufacturer's Certification Letters:** Submit copies of the Seismic Consultant's Letters of Assurance as specified above. Submit copies of the Seismic Consultant and seismic control manufacturer's certification letters as specified in Part 3 of this Section.
- .3 **Samples:** If requested, submit samples of seismic restraint materials for review.

1.04 QUALITY ASSURANCE

- .1 Seismic restraints are to be designed by a Seismic Consultant as specified above, and are to be installed by qualified tradesmen under the supervision of and to the approval of the Seismic Consultant.
- .2 Unless otherwise specified seismic control and restraints are to be designed in accordance with
 - .1 National Building Code of Canada
 - .2 CAN/CSA-S832, Seismic Risk Reduction of Operational and Functional Components (OFC's) of Buildings
 - .3 local Code requirements
- .3 All restraint products must be tested in an independent testing laboratory, or certified by the Vibration Isolation and Seismic Control Manufacturer's Association and Seismic Consultant, to confirm that the restraint products meet all requirements of this Section, i.e. dynamic ultimate limit load state as required by the Code, "Fail Safe" design, etc. If particular tests are carried out to represent a restraint type, the test is to be valid for the full load range of the restraint. Submit such tests or certification when requested.
- .4 Seismic control and restraint product manufacturers are to provide all required assistance during the installation, and, when the installation is complete, submit written reports from the manufactures listing any deficiencies to the installation.

2 PRODUCTS

2.01 GENERAL

- .1 Isolation, anchors, bolts, bases, restraints, etc., are to be designed to withstand without failure or yielding, the dynamic G load as specified in the Code for the seismic zone in which the building is located. Design loads are ultimate limit state loads (1.5 times working load) acting through the centre of gravity of the anchored or restrained equipment. "Fail Safe" designs are acceptable.
- .2 For both isolated and non-isolated floor mounted equipment, design and provide anchors and bolts to withstand, without failure or yielding, a dynamic ultimate limit state load as defined in the Code, of the greater of 0.3 g or as required by the Code, applied horizontally through the centre of gravity.
- .3 Where impact forces may be significant, use ductile materials.
- .4 Seismic restraining devices which are factory supplied with equipment are to meet all requirements of this Section.

2.02 ACCEPTABLE MANUFACTURERS OR APPROVED EQUIVALENT.

- .1 Acceptable seismic restraint product manufacturers are:
 - .1 Mason Industries Inc.

.2 Kinetics Noise Control

.3 Vibro-Acoustics Ltd.

.4 The VCM Group

2.03 SLACK CABLE RESTRAINTS

- .1 Galvanized steel aircraft cable slack cable restraints meeting all current requirements of the Building Code, sized to suit the application and complete with all required cable ties, anchor hardware (selected for a load equal to twice the weight of the equipment), and similar connection accessories.

2.04 ANCHOR BOLTS

- .1 Equal to Mason Industries type SAB seismic anchor bolts.

3 EXECUTION

3.01 INSTALLATION OF SEISMIC RESTRAINT MATERIALS

- .1 Provide seismic restraint for all electrical equipment, conduit, raceways, lighting fixtures, etc., as per the requirements of the current edition of the Building Code and this Section of the Specification.
- .2 Provide structural steel bases for all equipment unless the equipment manufacturer certifies direct attachment capabilities.
- .3 Space restraints under equipment so that the minimum distance between adjacent corner restraints is at least equal to the height of the centre of gravity of the equipment. Include the height of the centre of gravity on shop drawings, otherwise, design for increased forces on the supports and submit design calculations with shop drawings.
- .4 Floor mounted isolated equipment is to be installed on concrete housekeeping pads (design and thickness as selected by the Seismic Consultant) with at least 200 mm (8") clearance between drilled inserts and the edges of the pads. Ensure that all housekeeping pads are keyed to the structure to resist seismic displacement.
- .5 Requirements pertaining to seismic control work are as follows:
 - .1 execute seismic control and restraint work in accordance with drawing details and reviewed product data and shop drawings
 - .2 seismic control systems are to work in all directions
 - .3 fasteners and attachment points are to resist the same maximum load as the seismic restraint
 - .4 drilled or power driven anchors and fasteners are not permitted
 - .5 no equipment, equipment supports or mounts are to fail before failure of the structure
 - .6 seismic control measures are not to interfere with the integrity of firestopping

- .7 all equipment is to be bolted to the structure, and all bolts are to fitted with isolation washers
- .8 the number, size, type, and installation of anchor bolts are to be as recommended by the anchor bolt manufacturer and the Seismic Design Consultant
- .9 where more than a 3 mm (1/8") differential exists between an anchor or attachment bolt diameter, an anchor and attachment point hole, or an isolator gap attachment bolt and equipment anchor attachment hole, pack the air gap with Mason type 0.5 FastSteel reinforced epoxy putty
- .10 all hung equipment and hangers are to be fitted with a means of preventing upward movement, and non-isolated equipment and hanger rods are to be fitted with oversized steel washers and nuts above and below the hanger or equipment attachment point, locked tight to prevent uplift of the equipment or hanger
- .11 where suspended equipment hanger rod length exceeds 50 rod diameters between the structure and the equipment attachment point, reinforce the rods with angle iron to prevent bending due to uplift forces
- .12 seismic control measures are not to jeopardize noise and vibration isolation systems, and 6 mm (¼") to 9 mm (3/8") clearance during normal operation of equipment and systems is to be provided between seismic restraint and equipment
- .13 where hold-down bolts for seismic restraint equipment penetrate roofing membranes coordinate with roofing trade for installation of pitch pockets/"gum cups" and sealing compound to maintain the water-tight integrity of the roof
- .14 where friction type clamps are used for support of equipment and connecting services, secure clamps to steel work by means of welding or other positive means to prevent slippage or loosening of the clamps due to seismic force

3.02 SITE INSPECTION AND LETTERS OF CERTIFICATION

- .1 When all seismic control products have been installed, arrange for the seismic control product manufacturer and Seismic Consultant to examine the installation of all seismic control products and to certify in writing (separate letters) that the products have been properly installed in accordance with governing Codes and Regulations, and recommendations and instructions. The Seismic Consultant is to apply his signed and dated professional stamp to the letter.

End of Section

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies fire stopping and smoke seal requirements that are common to electrical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.02 SUBMITTALS

- .1 **Firestop & Smoke Seal System Samples:** At least four weeks prior to work commencing, submit a sample of each type of firestop and smoke seal system in applied form, for approval. Identify each system with the manufacturer's name and type, the ULC designation, and the proposed use. When the samples are approved, all work is to conform to the approved samples.
- .2 **Product Data & WHMIS Sheets:** Submit a product data sheet and a WHMIS sheet for each firestopping and smoke seal product.
- .3 **Name & Experience of Proposed Applicator:** Submit for approval the full company name and experience of the proposed firestopping and smoke seal system applicator.
- .4 **Letter of Certification:** Submit a letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

1.03 QUALITY ASSURANCE

- .1 **Applicator:** The applicator is to have a minimum of three years of successful experience on projects of similar size and complexity, and is to be approved by the Consultant.
- .2 **Environment Conditions:** Comply with the firestopping and smoke seal product manufacturer's recommendations regarding suitable environment conditions for product installation.

2 PRODUCTS

2.01 FIRESTOPPING AND SMOKE SEAL SYSTEM MATERIALS

- .1 Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with CAN4-S115, Standard Method of Fire Tests of Firestop Systems and CAN/ULC-S101, Standard Method of Fire Endurance Tests of Building Construction and Materials for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal, and a fire-resistance rating (flame, hose stream and temperature) not less than the fire resistance rating of surrounding fire rated construction.
- .2 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with the firestopping manufacturer's recommendations and the ULC tested assembly.

2.02 ACCEPTABLE MANUFACTURERS

- .1 Acceptable firestop and smoke seal manufacturers are as specified in front end documents, or:

- .1 A/D Fire Protection Systems "FIREBARRIER"
- .2 Tremco Inc. Fire Protection Systems Group "TREMstop"
- .3 3M Canada "Fire Barrier"
- .4 Hilti (Canada) Ltd. Firestop Systems
- .5 Approved Equivalent

3 EXECUTION

3.01 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where electrical work penetrates fire rated construction, provide ULC listed and labelled firestopping and smoke seal materials installed in accordance with requirements of CAN4- S115 (ratings F, FT, FH, and FTH as required), CAN/ULC-S101, and all other governing authorities to seal the penetrations.
- .2 **Preparation:** Abide by the following requirements:
 - .1 examine substrates, openings, voids, adjoining construction and conditions under which the firestop and smoke seal system is to be installed, and confirm compatibility of surfaces
 - .2 verify penetrating items are securely fixed and properly located with the proper space allowance between penetrations and surfaces of openings
 - .3 report any unsuitable or unsatisfactory conditions to the Contractor and Consultant in writing, prior to commencement of work, and note that commencement of work will mean acceptance of conditions and surfaces
 - .4 mask where necessary to avoid spillage and over coating onto adjoining surfaces, and remove stains on adjacent surfaces
- .3 **Application:** Conform to the following application requirements:
 - .1 use an experienced applicator approved by the manufacturer of the firestopping material manufacturer
 - .2 prime substrates in accordance with the product manufacturer's written instructions
 - .3 provide temporary forming as required and remove only after materials have gained sufficient strength and after initial curing
 - .4 tool or trowel exposed surfaces to a neat, smooth, consistent finish
 - .5 remove excess compound promptly as work progresses and upon completion
 - .6 at all cable transit locations, seal the perimeter of the angle iron framing on both sides of the wall or slab with ULC listed and labelled sealant materials to provide a positive smoke seal

- .4 **Inspection:** Notify the Consultant when the work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies. Arrange for final inspection of the work by the Municipal Building Inspector prior to concealing or enclosing work. Make any corrections required.
- .5 **Certification:** On completion of the firestopping and smoke sealing installation submit a letter of assurance to the Consultant certifying that the firestopping and smoke sealing installation has been carried out throughout the building to all electrical service penetrations and that the installation has been done in strict accordance with the requirements of the Provincial Building Code, any applicable local Municipal Codes, ULC requirements, and the manufacturer's instructions.

End of Section

1 GENERAL

1.01 SUBMITTALS

- .1 **Test Reports:** Submit signed test reports for all testing work specified.
- .2 **Approval Certificates:** Submit Certificates of Approval as issued by governing authorities.
- .3 **Electrical Distribution System Coordination Study:** Submit copies of the electrical distribution system protective device coordination study specified in Part 3 of this Section, prior to energizing the electrical distribution equipment.

2 PRODUCTS

NOT APPLICABLE

3 EXECUTION

3.01 GENERAL ELECTRICAL WORK TESTING REQUIREMENTS

- .1 Satisfactorily perform all testing required by governing authorities, Codes, Regulation and the Specification, including general testing specified below. Prepare and sign test reports to confirm satisfactory completion of testing and submit as specified in Part 1 of this Section.
- .2 Perform testing to suit phasing of the work, as applicable.
- .3 **Leaks, Grounds, and Crosses:** After luminaries, switches, receptacles, motors, signals, and similar equipment has been installed, whether or not the work has been installed as part of the work of this Division of the Specification or by other Divisions (telephone system excepted), test the work to ensure that there are no leaks, grounds, or crosses.
- .4 **Motor Operation:** Test and establish proper motor rotation, measure full load running currents, and check overload elements. Report to the Consultant any discrepancies that are found. Existing motors that have been disconnected and reconnected as part of the electrical work must be checked with rotation meter, and be responsible for any damage caused by reverse rotation.
- .5 **Branch Circuit Voltage Drop:** Demonstrate to the Consultant that branch circuit voltage drop is within specified limits.

3.02 GROUNDING AND BONDING SYSTEM

- .1 Provide visual and mechanical inspection of the grounding and bonding system and verify that the system is in compliance with all requirements.

3.03 DISTRIBUTION SYSTEM TESTING AND COORDINATION STUDY

- .1 The electrical distribution system protective devices have been selected such that protection is adequate and proper coordination is possible, however, since differences do exist between manufacturers of equipment, some changes in trip ratings or relay settings may be necessary and are to be performed as part of the work, prior to energizing the electrical distribution system.

To determine the above, a testing and coordination study of the electrical distribution system equipment is to be performed by one of the following companies:

- .1 G.T. Wood Co. Ltd.
 - .2 Brosz and Associates Ltd.
 - .3 Rondar Inc.
 - .4 Haronitis & Associates Ltd.
 - .5 Enkompass
 - .6 Approved equivalent company with experience in testing and coordination of the electrical distribution system.
- .2 Conform to requirements of CAN/CSA Z32, Electrical Safety and Essential Systems in Health Care Facilities.
- .3 **Short Circuit and Coordination Study:** Immediately upon notification of award of Contract, arrange for the testing company to perform the following:
- .1 cooperate with and obtain from manufacturers of the distribution system equipment a list of equipments requiring protective devices to be used, and along with the manufacturers, ensure that proper control and protective devices are selected such that they can be properly coordinated
 - .2 prepare, as soon as possible, a set of coordination curves on proper time current characteristic graph paper and submit to the Consultant, accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to verify protection of the various distribution system elements under maximum and minimum fault conditions at the various points in the system
 - .3 plot the time current characteristic curves for the following:
 - .1 main and feeder protective devices at voltage levels used in the distribution system
 - .2 protective devices associated with the largest motor in each motor control centre, the refrigeration machine compressors (as applicable), and the largest lead fed from each distribution panelboard
 - .3 emergency power engine generator set protective devices, damage curves, and current decrement curves
 - .4 where relays, breakers, etc., do not perform to approved coordination curves they are to be revised at no cost as part of the work
 - .4 Review the existing distribution equipment and, where possible, obtain the existing distribution system coordination study to determine the best coordination between the existing and new equipment. If an existing coordination study is not available, survey the existing equipment and prepare calculations of proper coordination between the new and existing equipment. Where

-
- defective or incorrectly applied relays or breakers are found, clearly identify the problem on curves submitted with the report and suggest a recommended course of action.
- .5 The on-site test and coordination study of distribution system protective devices is to include, as applicable:
- .1 testing, cleaning when necessary, and calibrating relays and circuit breaker trip devices (calibration) of protective devices is to conform to requirements of approved coordination (curves).
 - .2 a function test of associated control device
 - .3 replacement of any fuses destroyed during tests
 - .4 an acceptance test in the presence of and to the satisfaction of the Consultant
 - .5 the presence at the site, for the length of time required, of qualified equipment manufacturer's representatives
 - .6 an insulation resistance test of "load" side feeders with respect to ground
 - .7 testing of motor control centres, motor starters, and where supplied as part of the electrical work, viable speed drives
 - .8 witnessing EMI testing and signing test reports as verification of result
- .6 **Arc Flash Hazard Analysis:** Perform an arc hazard analysis and prepare and submit a report with calculations to determine the flash protection boundary and the incident energy at locations in the electrical distribution system (switchboards, switchgear, motor control centres, distribution panelboards, bus duct, splitters), and other equipment where work could be performed on energized equipment. Include significant locations in systems fed from transformers 125 kVa and greater, and specify safe working distances for calculated fault locations based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm². Provide minimum 90 mm x 125 mm (3½" x 5") thermal transfer type high adhesion polyester warning labels at each work location and piece of equipment analyzed. Labels are to have an orange header with machine printed wording warning, ARC FLASH HAZARD, and the following information:
- .1 nominal voltage
 - .2 flash protection boundary
 - .3 hazard risk category
 - .4 incident energy
 - .5 working distance

End of Section

1 GENERAL

1.01 APPLICATION

- .1 This Section specifies mounting height requirements that are common to electrical work Sections of the Specification, and it is a supplement to each Section and is to be read accordingly.
- .2 Reference 26 05 00 – ELECTRICAL WORK GENERAL INSTRUCTIONS

2 PRODUCTS

2.01 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting heights of equipment are not specified or indicated, verify with the Consultant prior to rough-in and installation.
- .3 Unless indicated otherwise on the drawings or within the specifications, install electrical equipment at following heights;
 - .1 Local switches – no lower than 900mm and no higher than 1100mm
 - .2 Wall receptacles:
 - .1 General – 400mm (to bottom of receptacle)
 - .2 Above top of continuous baseboard heater – 200mm
 - .3 Above top of counters or counter splash backs – 175mm
 - .4 In mechanical rooms – 1000mm
 - .5 In equipment storage rooms – 1000mm
 - .3 Panelboards – 2000mm to top of panel and as required by Electrical Safety Code
 - .4 Telephone and interphone outlets – 400mm (to bottom of receptacle)
 - .5 Wall mounted telephone and interphone outlets – no lower than 900mm and no higher than 1100mm
 - .6 Thermostats – 1200mm to the point of controls
 - .7 Fire Alarm stations – 1200mm to the top of point of operating action
 - .8 Wall Mounted Fire Alarm Audible Devices – 2300mm
 - .9 Television outlets not mounted behind a wall mounted television – 400mm (to bottom of receptacle)
 - .10 Wall mounted speakers – 2100mm
 - .11 Clocks – 2100mm
 - .12 Handicap pushbuttons – no lower than 900mm and no higher than 1100 mm

.13 Wall mounted Exit Signs

- .1 For ceilings up to 2500mm height – 2100mm
- .2 For all ceilings greater than 2500mm – 2400mm

.14 Wall mounted Battery Packs and Emergency Heads

- .1 For ceiling up to 2500mm height – 2100mm
- .2 For all ceilings greater than 2500mm – 2400mm

.15 Wall mounted occupancy sensors – no lower than 900mm and no higher than 1100mm

.16 Wall mounted visible signal devices – entire lens shall be no less than 2000mm and no more than 2400mm

Note: In all applications the visible signal device shall be located to provide optimal viewing by the occupants. There may be applications where mounting heights outside of the range described would be more suitable and should be reviewed based on space layout and brought up to Engineer as construction progresses.

.17 Top of remote annunciator and passive graphic panels shall be no more than 1800mm above finished floor

End of Section

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for all products specified in this Section. Indicate compatibilities and limitations, and application instructions.
- .2 **Samples:** If requested, submit identified conductor samples.
- .3 **MSDS Sheets:** Submit Material Safety Data Sheets for conductor pulling lubricants.
- .4 **Type "MI" Cable Certifications:** Submit a minimum of four copies of a letter from the cable manufacturer certifying proper cable installation and successful testing as specified in Part 3 of this Section, and include cable test sheets.

2 PRODUCTS

2.01 DISTRIBUTION AND BRANCH CIRCUIT CONDUCTORS

- .1 Conductors to and including No. 10 AWG are to be solid. Conductors larger than No. 10 AWG are to be stranded. All conductors are to be constructed from 98% conductive copper and are to be approved for 600 volts. Conductors are to be colour coded, factory identified on the insulation with the manufacturer's name, conductor size and metal, voltage rating, and CSA type and designation. Conductors are to be as follows:
 - .1 "T-90 Nylon" single conductor in accordance with CSA C22.2 No. 75, Thermoplastic- Insulated Wires and Cables, 90° C (195° F) rated, PVC insulated and nylon covered
 - .2 "RW-90" single conductor in accordance with CAN/CSA C22.2 No. 38, Thermoset- Insulated Wires and Cable, 90° C (195° F) rated, X-link polyethylene insulated
 - .3 "TWU" single conductor in accordance with CSA C22.2 No. 75, -40° C (-40° F) rated, PVC insulated
 - .4 "AC90" flexible cable to CSA C22.2 No. 51, Armoured Cable, with 90° C (195° F) rated, X-linked polyethylene insulated conductors, a concentric ground conductor, and an interlocking aluminium armour jacket
 - .5 "A90 ISO-BX" flexible cable to CSA C22.2 No. 51, Armoured Cable, with 90° C (195° F) rated, X-linked polyethylene insulated conductors, a concentric bare ground conductor, an insulated ground conductor, and an interlocking aluminium armour jacket
 - .6 equal to Nexans Canada "Corflex" II" RA90 flexible cable in accordance with requirements of CSA C22.2 No. 123, Aluminium Sheathed Cable, consisting of single or multiple copper conductors with X-link polyethylene insulation enclosed in a liquid and vapour-tight solid corrugated aluminium sheath and, as required, an overall PVC jacket

- .7 equal to Nexans Canada "Firex II" TECK 90 cable in accordance with requirements of CSA C22.2 No. 131, Type TECK 90 Cable, consisting of single or multiple copper conductors with X-link polyethylene insulation enclosed in a liquid and vapour-tight solid corrugated aluminium sheath and, where required, an overall PV C jacket

2.02 LOW VOLTAGE (24 VOLT) CONDUCTORS

- .1 "T-90" or "RW90" stranded copper conductors as specified above.
- .2 Equal to Nexans Canada "Securex II" FAS/LVT/FT1300 volt wire to CSA C22.2 No. 208, Fire /Alarm and Signal Wire, 105° C (220° F) rated, consisting of solid copper conductors (stranded for control wiring), flame retardant PVC insulation, an aluminium/Mylar optional shield with a #22 AWG tinned copper insulation and a drain wire, and, if required for the application, interlocking aluminium armour with or without an overall jacket.

2.03 CONNECTORS

- .1 **Conductors In Conduit:** Except as noted, equal to Ideal Industries Inc. "Wing Nut" CSA certified, 60 volt rated pressure type twist connectors.
- .2 **Conductors 3/0 AWG and Larger:** Long barrel, double crimp, compression type lug connectors, unless otherwise specified.
- .3 **Armoured Cable:** Except as noted, proper squeeze type connectors and plastic anti- short bushings at terminations in accordance with requirements of CSA C22.2 No. 18.3, Conduit, Tubing and Cable Fittings.
- .4 **Mineral Insulated Conductors:** Tyco/Pyrotenax "Pyropak" connectors, complete with brass plates with drilled and tapped mounting holes for connections to ferrous cabinets or approved equivalent.
- .5 **Corflex/Teck Cable:** Connector and termination hardware supplied by the cable manufacturer to suit the application.

2.04 CONDUCTOR PULLING LUBRICANT

- .1 Equal to Ideal Industries Inc. "Yellow 77" or "ClearGlide", as required.
- .2 French Chalk or Talcum Powder conductor pulling lubricant.

3 EXECUTION

3.01 Conform to the following conductor installation requirements:

- .1 **Conductor Routing:** Conductor routing indicated on the drawings is schematic and approximate. Determine exact routing and conductor lengths at the site. Route conductors to avoid interference with other work. Unless otherwise specified or shown install conductors parallel to building lines.
- .2 **Conductor Pulling:** When pulling conductors into conduit use lubricant and ensure that the

conductors are kept straight and are not twisted. For isolated power centre “load” side power wiring, use only French Chalk pulling lubricant.

.3 Securing/Supporting Conductors: Conform to the following requirements:

- .1 neatly secure exposed conductors in equipment enclosures with proper supports and/or ties
- .2 support flexible armoured cable in ceiling spaces and stud walls with steel two-hole cable straps to Code requirements

.4 Conductor Splicing: Generally, conductor splicing is not permitted unless otherwise approved by the Consultant, and if approved splicing is subject to the following conditions:

- .1 splicing is permitted to extend existing conductors
- .2 for thermoplastic insulated conductors, splices are to be made within an approved electrical box with mechanical compression connectors to suit the type and size of conductors, and the box(es) are to be properly identified and locations are to be indicated on “as-built” drawings
- .3 do not splice mineral insulated “MI” cable
- .4 do not splice “Corflex” cable unless justified by cable pulling tension calculations and when approved by the Consultant, and, if approved, locate splices where directed by the Consultant

3.02 INSTALLATION OF DISTRIBUTION AND BRANCH CIRCUIT CONDUCTORS

.1 Provide all required conductors.

.2 Non-Fire Rated Conductors: Unless otherwise specified herein or on the drawings, non- fired rated conductors are to be used as follows:

- .1 conductors underground inside or outside the building, and in non-climate controlled areas – **TWU**
- .2 unless otherwise specified, conductors in accessible ceiling spaces, within stud wall construction, and in furniture systems to luminaries and wiring devices – **AC90 (BX) flexible armoured cable, maximum 6 m (20') run permitted**
- .3 for isolated power system wiring – **RW90**
- .4 for conductors in medical headwalls and service consoles, and as per drawing details – **T90 Nylon or RW90 in flexible conduit, or AC90 ISO-BX to Code requirements**
- .5 for conductors except as specified above or elsewhere in the Specification or on the drawings – **T90 Nylon or RW90**

.3 “Corflex” or approved equivalent Cable Installation Requirements: Install “Corflex” cable in accordance with the manufacturer’s instructions, including the following requirements:

- .1 support and secure overhead suspended “Corflex” cable on a system of cable tray where indicated

-
- .2 secure individual cables to cable tray, or where shown, directly to building surfaces by means of single screw non-ferrous clamps
 - .3 ground and bond single conductor cable at both ends where the sheath currents do not affect the cable ampacity
 - .4 for certain areas, where the sheath currents will reduce the cable ampacity, ground and bond the cable at the supply end and isolate the cable at the load end as recommended by the cable manufacturer, and provide a No. 3/0 AWG green TW ground conductor for each cable, all as per Section No. 10 of the Ontario Electrical Safety Code
 - .4 **“Teck” Cable Installation Requirements:** Install “Teck” cable in accordance with the manufacturer’s instructions, including the following requirements:
 - .1 support and secure overhead suspended “Teck” cable tray where indicated
 - .2 secure individual cables to cable tray or, where shown, directly to building surfaces by means of single screw non-ferrous clamps
 - .3 terminate cable with lugs and termination kits supplied with the cable
 - .5 **Conductor Sizing:** Generally, conductor sizes are indicated on the drawings. Unless otherwise specified, do not use conductors smaller than No. 12 AWG in systems over 30 volts. Unless otherwise specified, do not use conductors smaller than No.6 AWG for exterior luminaire wiring. Conductor sizes indicated on the drawings are minimum sizes and must be increased, where required, to suit length of run and voltage drop in accordance with the voltage drop schedule found at the end of this Section.
 - .6 **Conductor Colour Coding:** Unless otherwise specified, colour code conductors to identify phases, neutral, and ground by means of self-laminating coloured vinyl tape, coloured conductor insulation, or properly coloured plastic discs. Colours are to be as follows:
 - .1 phase A – red
 - .2 phase B – black
 - .3 phase C – blue
 - .4 neutral – white
 - .5 control – orange
 - .7 **Communication System Colour Coding:** Unless otherwise specified, colour code conductors for communication systems in accordance with the system manufacturer’s recommendations.

MAX. BRANCH WIRING DISTANCE FOR 120 VOLT SYSTEM AT 2% VOLTAGE DROP

Wire Size	Breaker Size (AMPERES)	15	20	30	40	50	60	70	80	100
	MAX LOAD AT 80% (AMPERES)	12	16	24	32	40	48	56	68	80
No 12.	-----	16.8	12.2	-----	-----	-----	-----	-----	-----	-----
No 10	-----	25.9	19.0	-----	-----	-----	-----	-----	-----	-----
No. 8	-----	39.6	30.4	12.9	-----	-----	-----	-----	-----	-----
No. 6	-----	62.4	47.2	32.0	23.6	19.0	16.0	-----	-----	-----
No.4	-----	99.0	73.1	50.2	38.1	30.4	24.3	21.3	19.0	-----
No. 2	-----	-----	114.3	77.2	57.9	47.2	38.8	33.5	28.9	22.8
No. 1	-----	-----	-----	96.0	73.1	57.9	47.2	42.6	36.5	27.4
No.1/0	-----	-----	-----	-----	85.3	68.5	56.3	48.7	41.9	33.5
No. 2//0	-----	-----	-----	-----	102.8	80.7	67.0	57.9	50.2	40.3
No. 3/0	-----	-----	-----	-----	-----	95.2	79.2	68.5	59.4	47.2
No. 4/0	-----	-----	-----	-----	-----	-----	92.9	79.2	70.1	56.3
250 MCM	-----	-----	-----	-----	-----	-----	102.8	86.8	76.2	60.9
300 MCM	-----	-----	-----	-----	-----	-----	-----	100.5	88.3	70.1

NOTE: DISTANCES INDICATED IN METRES FROM PANEL TO LOAD FOR SINGLE PHASE

MAX. BRANCH WIRING DISTANCE FOR 120 VOLT SYSTEM AT 3% VOLTAGE DROP

Wire Size	Breaker Size (AMPERES)	15	20	30	40	50	60	70	80	100
	MAX LOAD AT 80% (AMPERES)	12	16	24	32	40	48	56	68	80
No 12.	-----	24.4	18.3	-----	-----	-----	-----	-----	-----	-----
No 10	-----	38.1	29.0	19.1	-----	-----	-----	-----	-----	-----
No. 8	-----	59.4	44.2	30.5	22.9	-----	-----	-----	-----	-----
No. 6	-----	91.4	70.1	47.2	35.1	28.2	23.6	-----	-----	-----
No.4	-----	-----	109.7	73.2	54.9	42.7	38.1	32.0	27.4	-----
No. 2	-----	-----	-----	114.3	85.3	68.6	57.9	50.3	41.1	35.0
No. 1	-----	-----	-----	-----	103.6	85.3	73.2	61.0	54.9	43.4
No.1/0	-----	-----	-----	-----	128.0	102.9	85.3	73.2	64.0	48.8
No. 2//0	-----	-----	-----	-----	-----	122.9	100.6	86.9	74.7	60.9
No. 3/0	-----	-----	-----	-----	-----	-----	118.1	102.1	88.4	70.1
No. 4/0	-----	-----	-----	-----	-----	-----	-----	120.4	102.9	83.8
250 MCM	-----	-----	-----	-----	-----	-----	-----	-----	114.3	91.4
300 MCM	-----	-----	-----	-----	-----	-----	-----	-----	-----	103.6

NOTE: DISTANCES INDICATED IN METRES FROM PANEL TO LOAD FOR SINGLE PHASE

End of Section

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for all products specified in Part 2 of this Section except for copper wire/cable conductors.

1.02 QUALITY ASSURANCE

- .1 Grounding and bonding work is to be in accordance with requirements of the following:
 - .1 CSA C22.2 No. 41, Grounding and Bonding Equipment (Tri-National Standard with UL 467)
 - .2 CSA C22.2 No. 0.4, Grounding and Bonding of Electrical Equipment
 - .3 requirements of the Electrical Safety Authority and any other governing authority
 - .4 CAN/CSA Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities

1.03 COORDINATION

- .1 Coordinate the installation of grounding hardware and conductors associated with concrete with the trades providing the concrete work.

2 PRODUCTS

2.01 GROUND RODS

- .1 Copper clad solid steel round rods, 20 mm ($\frac{3}{4}$ ") diameter, 3 m (10') long, each complete with driving cap, pointed bronze tip, and a #14 gauge hot dipped galvanized steel or PVC, 250 mm (10") diameter, 300 mm (12") long ground rod box with a vandal-proof removable identified cover.

2.02 GROUND PLATES

- .1 Copper plates, 1 m² (11 ft.² surface area, 6 mm ($\frac{1}{4}$ ") thick.

2.03 GROUND MAT

- .1 Copper mesh gradient control mat, 1.5 m (5') square, 2 mm ($\frac{3}{32}$ ") thick, 50 x 50 mesh.

2.04 GROUND BUS

- .1 Solid electrical grade copper, minimum 50 mm x 6 mm (2" x $\frac{1}{4}$), minimum 600 mm (24") long but with lengths as required (continuous lengths for health care and data centre projects), predrilled for two-hole lug connections, suitable for wall or backboard mounting and complete with corner angles, tamper-proof stainless steel hex head bolts, nuts, and spring lock washers, standoff insulators, and all connection hardware.

2.05 FLEXIBLE GROUND BRAID

- .1 Flat 98% conductivity tinned copper grounding braid with dimensions to suit the application.

2.06 GROUND CONDUCTORS

- .1 Unless otherwise specified and/or shown. Stranded un-tinned soft annealed copper wire, bare or green PVC insulated conforming to the requirements of the Section entitled Wire and Box Connectors (0-1000volts).

2.07 GROUNDING AND BONDING CONNECTIONS

- .1 **Below Grade:** Equal to Erico International Corp. "CADWELD" exothermic welded connections.
- .2 **Above Grade:** Compression type connectors with zinc-plated fasteners and external tooth lock washers, or, if approved by the Consultant, exothermic Erico International Corp. "CADWELD" welded connections.

2.08 COMMUNICATIONS, ACCESS CONTROL, & ELECTRONIC SAFETY SYSTEM GROUND BUS

- .1 Solid electrical grade copper bus bars, minimum 6 mm x 20 mm ($\frac{1}{4}$ " x $\frac{3}{4}$ ") designed for mounting on the framework of open or cabinet enclosed equipment racks.

2.09 LAN ROOM GROUND BUS

- .1 Solid electrical Grade copper bus bars, 300 mm x 50 mm x 9 mm (12" x 2" x $\frac{3}{8}$ ") with 8 drilled holes, suitable for wall mounting and equipped with standoff insulators.

3 EXECUTION

3.01 GENERAL RE: GROUNDING AND BONDING

- .1 Perform all required grounding and bonding work in accordance with the Contract Documents and requirements of governing Codes and Standards, including the Electrical Safety Authority.
- .2 Bond metallic conduits, boxes, cable tray, ducts, and non-current carrying metal parts of equipment together to form a continuous ground system. In electrical equipment rooms, solidly bond circuits, panelboards, conduits, equipment enclosures, and other equipment to perimeter ground bus using bronze connectors and hardware.
- .3 Protect exposed conductors from injury. Install underground conductors a minimum of 450 mm (18") below grade.
- .4 Use tinned copper conductors for aluminium structures.
- .5 Do not use bare copper conductors adjacent to un-jacketed lead sheath cables.

3.02 GENERAL PRIMARY GROUNDING AND BONDING REQUIREMENTS

- .1 Grounding and bonding work associated with primary electric service work is to be performed only by qualified journeyman electricians employed by the subcontractor doing the primary electric service work.
- .2 Provide a separate ground conductor in all PVC conduits.

3.03 INSTALLATION OF GROUND ROD GRIDS

- .1 Construct ground rod grids consisting of copper clad steel ground rods as indicated/specified where indicated, each consisting of the number of rods shown, driven into the earth a minimum of 300 mm (12") below grade and terminated with a galvanized steel box enclosing the ground conductor clamp, and interconnected with minimum #3/0 AWG bare copper conductor. Flush with grade at each ground rod, provide an identification monument.

3.04 INSTALLATION OF PLATE ELECTRODE GRID

- .1 Provide a plate electrode ground grid where indicated/specified.
- .2 Bury the plate electrode level a minimum of 765 mm (30") below grade and connect with minimum #3/0 AWG bare copper conductor. Flush with grade at each plate electrode, provide an identification monument.

3.05 INSTALLATION OF GROUND BUS

- .1 Provide ground bus where shown/specified. Wall mount 300 mm (12") above finished floor level on standoff insulators and follow the outline of door frames and room corners using 90° bus angles to form continuous bus. Connect the ground bus to the ground rod grid by means of two minimum #3/0 copper conductors terminated with approved fittings.
- .2 Provide flexible braided copper ground straps from the ground bus to each steel door frame and door in the room, each securely bolted in place.
- .3 Tighten all bus bar joint connection bolts and lug using a torque wrench to the bus manufacturer's prescribed tension, then coat the bus with two 100% covering coats of shellac to prevent copper oxidization.

3.06 NEUTRAL GROUNDING

- .1 Connect transformer neutral and distribution neutral together using 1000 volt insulated conductor to one side of a ground test link, the other side of the test link being connected directly to the main station ground. Ensure that distribution neutral and neutrals of potential transformers and service banks are bonded directly to the transformer neutral and not to the station ground.
- .2 Connect the neutral of the station transformer to the main neutral bus with a tap of the same size as the secondary neutral.

- .3 Ground the transformer tank with a continuous conductor from the tank ground lug through the connector on the ground bus to the primary neutral. Connect the neutral bushing at the transformer to the primary neutral in the same manner.

3.07 ELECTRICAL MANHOLE GROUNDING

- .1 Provide a conveniently located ground stud, electrode, and ground conductor in each electrical manhole. Install the ground rod with the lug for the ground connection so that the top of the rod projects through the bottom of the manhole.

3.08 CABLE SHEATH GROUNDING

- .1 Bond single conductor metallic sheathed cables together at on end only. Break the sheath continuity in an approved manner, and provide #6 AWG flexible copper ground conductor soldered (not clamped) to the cable sheath.

3.09 LOCAL AREA NETWORK (LAN) ROOM GROUNDING

- .1 Provide minimum 3/0 AWG insulated copper ground conductors and wall mounted copper ground bus in each LAN Room. Connect the ground bus to computer equipment racks and to the building ground system.

3.10 TELECOMMUNICATIONS SYSTEMS GROUNDING

- .1 Provide all required conductors and hardware to properly ground and bond communication system raceways, cable tray, metallic cable shields, and equipment to a ground source in accordance with requirements of TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.

End of Section

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** If requested, submit product data sheets for products specified in this Section.
- .2 **Samples:** If requested, submit samples of products specified in this Section.

2 PRODUCTS

2.01 SPLITTER TROUGH

- .1 Formed #16 gauge steel Type 1 splitter trough in accordance with CSA C22.2 No. 76, Splitters, finished inside and outside with ANSI 61 gray heat cured powder epoxy paint, and complete with welded seams ground smooth, various size knockouts on each side, back mounting holes, removable doors with stainless steel hinges and hinge pins, terminal blocks for conductor connections, a single point ground lug
- .2 **Enclosures:** Unless otherwise specified, enclosures are to be in accordance with the following NEMA/EEMAC ratings:
 - .1 all enclosures located in sprinklered areas – Type 2
 - .2 all enclosures except as noted above – Type 1

2.02 PULL BOXES AND JUNCTION BOXES

- .1 Each box is to be CSA certified, sized to suit the number and size of conduit and conductors, and complete with connecting and securing facilities. Unless otherwise specified, pull boxes and junction boxes are to be as follows:
 - .1 galvanized or prime coat plated steel, suitable in all respects for the application and complete with screw-on or hinged covers as required and connectors suitable for the connected conduit
 - .2 “Condulet”, threaded galvanized cast iron or cast aluminium pull boxes and junction boxes of an exact type to suit the application, each complete with screw-on gasketed cover
 - .3 rigid plastic (PVC), junction boxes and access fittings with solvent weld type joints and screw-on PVC covers
 - .4 equal to Square D (Schneider Canada) Catalogue No. 970 cast bronze water-proof junction box for underwater lighting

3 EXECUTION

3.01 INSTALLATION OF SPLITTER TROUGH

- .1 Provide all required splitter trough in accordance with drawing plans, schedules, details, and requirements of the Specification.
- .2 Rigidly secure that the splitter trough in place, level and plumb.
- .3 Ensure that the splitter trough itself, and all branch circuits are properly identified.

3.02 INSTALLATION OF PULL BOXES AND JUNCTION BOXES

- .1 Provide pull boxes in conduit systems wherever shown on the drawings, and/or wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30 m (100') in length, or with more than three 90° bends, are to be equipped with a pull box installed at a convenient and suitable intermediate accessible location.
- .2 Provide junction boxes wherever required and/or indicated on the drawings.
- .3 Unless otherwise specified, boxes are to be as follows:
 - .1 in rigid conduit and EMT inside the building – stamped galvanized or prime coated steel
 - .2 in exterior rigid conduit – “Condulet” cast aluminium gasketed boxes unless otherwise noted
 - .3 in plastic conduit – rigid PVC boxes
 - .4 in bronze underwater conduit – cast bronze boxes
- .4 All pull boxes and junction boxes must be accessible after the work is complete.
- .5 Accurately locate and identify all concealed pull boxes and junction boxes on “as-built” record drawings.
- .6 Cover boxes in fire walls with aluminium tape and seal with caulking.

End of Section

GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** If requested, submit product data sheets for products specified in this Section.
- .2 **Samples:** If requested, submit samples of products specified in this Section.

2 PRODUCTS

2.01 OUTLET BOXES

- .1 Each box is to be CSA certified, suitable in all respects for the application, and be complete with suitable securing lugs, connectors suitable for the connected conduit, knockouts, and, where necessary, suitable plaster rings, concrete rings, covers and any other required accessory. Unless otherwise specified, outlet boxes are to be as follows:
 - .1 stamped, electro-galvanized steel outlet boxes
 - .2 zinc coated cast malleable iron or cast aluminum "FS and "FD" boxes with threaded inlet/outlet hubs
 - .3 rigid PVC outlet boxes
 - .4 equal to Hubbell Canada Inc. UL/ULC or ETL or listed fully adjustable both vertical and angular, formed galvanized cast iron, round, rectangular, or square as required flush concrete floor boxes complete with adjustable collars and brass screw-on hinged flip-open cover with provisions for installation of duplex power receptacles, telephone data jacks, and, for boxes containing both power and communication system outlets, proper barriers are to be provided
 - .5 Hubbell or Legrand-Wiremold flush, fire rated "poke-through" box assemblies to suit the devices required, with gray, black or brass flanges and covers as selected by the Consultant.
 - .6 Approved equivalent.

3 EXECUTION

3.01 INSTALLATION OF OUTLET AND CONDUIT BOXES

- .1 Provide an outlet box or back box for each luminaire, wiring device, telephone outlet, fire alarm system component, communications systems components, and all other such outlets.
- .2 **Stamped Galvanized Steel:** Outlet boxes flush mounted in interior construction, surface mounted in concealed interior locations, and surface mounted in exposed interior locations where the connecting conduit is EMT are to be stamped galvanized steel outlet boxes unless otherwise noted.
- .3 **"FS" and "FD" Series Boxes:** Outlet boxes for surface mounted for exterior lighting, receptacles, and other device outlets, boxes flush mounted in exterior building surfaces, and boxes mounted in interior device locations where the connecting conduit is rigid, and for boxes in perimeter walls where insulation and vapour barrier is present, are to be "FS" or "FD" Series cast boxes unless otherwise noted, cast iron inside the building, cast aluminium outside the building.

3.02 Rigid PVC Boxes In New Concrete Slabs: Provide rigid PVC outlet boxes in locations as follows:

- .1 in underground polyethylene conduit systems
- .2 for devices connected to isolated power system panelboards
- .3 for rigid PVC conduit systems where permitted
- .5 **Flush Floor Boxes:** Provide water-tight flush floor boxes where shown, installed in accordance with the manufacturer's instructions, and ensure that the boxes are not dislodged during the concrete pour.
- .6 **Flush Floor Boxes In Existing Concrete Slabs:** Flush "poke-through" box assemblies installed in 75 mm (3") diameter core drilled openings and connected with conduit at the underside of the slab.
- .7 Outlet boxes for special wiring devices, for special equipment and special applications if required, are specified hereinafter in other Sections or on the drawings.
 - .8 The size and arrangement of outlet boxes are to suit the device which they serve.
- .9 Generally, mounting heights and locations for outlets are indicated on the drawings, however, confirm the exact location and arrangement of all outlets prior to roughing-in. Architectural drawings and the Consultant's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting height and locations. In addition, abide by the following requirements:
 - .1 locate flush mounting boxes in masonry walls to require cutting of the masonry unit corner only, and coordinate masonry cutting to achieve a neat opening
 - .2 position outlet boxes to locate luminaires as shown on reflected ceiling plans
 - .3 coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes
- .10 Do not install outlet or back boxes "back-to-back" in walls and partitions. Stagger such outlets and seal against noise transmission with acoustic insulation. "Thru-wall" type boxes will not be permitted for any application.
- .11 Where boxes are multi-ganged or grouped together, mount boxes level and spaced consistently.
- .12 Temporarily pack all open boxes located in concrete and masonry to prevent debris from entering the box.
- .13 Include all costs for installed boxes that have not been covered by wall/ceiling finishes, to be relocated up to 1 m (3') to suit final device location coordination.

- .14 Provide blank coverplates over all boxes left empty for future installation of devices. Clearly identify each box as to its intended use to the Consultant's approval. Generally, blank overplates are to be stainless steel.

End of Section

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for all products where submittal is specified in Part 2 or Part 3 of this Section.
- .2 **Colour Coated EMT Colour Chart:** Submit the colour coated EMT manufacturer's standard colour chart for colour selection(s) by the Consultant.
- .3 **Drawing(s) of Conduit Locations/sizes In Structural Poured Concrete:** As specified in Part 3 of this Section, submit drawings to indicate the proposed location, size, and length of run for conduit proposed to be installed in structural poured concrete work.

2 PRODUCTS

2.01 EMT

- .1 Galvanized steel to CSA C22.2 No. 83, Electrical Metallic Tubing, complete with factory made bends where site bending is not possible, and joints and terminations made with steel couplings and set screw type connectors, concrete tight where required.

2.02 RIGID GALVANIZED STEEL CONDUIT

- .1 Rigid galvanized steel to CSA C22.2 No. 45, Rigid Metal Conduit, with an enamel interior coating, galvanized threads where factory threaded, red lead coated threads where site threaded, factory made bends where site bending is not possible, factory made threaded fittings and connectors, and terminations made with rigid couplings, concrete tight where required.

2.03 FLEXIBLE GALVANIZED STEEL LIQUID-TIGHT CONDUIT

- .1 Flexible galvanized steel liquid-tight conduit to CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit, complete with Ideal Industries Inc. "Steel Tough" liquid-tight connectors at terminations or approved equivalent.

2.04 FLEXIBLE GALVANIZED STEEL CONDUIT

- .1 Galvanized steel flexible conduit to CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit, complete with proper and suitable squeeze type connectors at terminations.

2.05 RIGID ALUMINUM CONDUIT

- .1 Factory or site threaded rigid aluminium to CSA C22.2 No. 45, Rigid Metal Conduit, with bending, threading, fitting, coupling, etc., requirements as specified for rigid galvanized steel conduit.

2.06 RIGID PVC CONDUIT

- .1 Rigid PVC conduit to CSA C22.2 No. 211.1, Rigid Types EB1 and DB2/ES2 PVC Conduit, FT-4 rated, complete with site made heat gun bends for conduit to and including 50 mm (2") diameter, factory made fittings for conduit larger than 50 mm (2") diameter, solvent weld joints, factory made expansion joints where required, and terminations made with proper and suitable connectors and adaptors.

2.07 FISH CORD

- .1 Polyethylene or nylon fish cord/tape with cable pull accessories to suit the application.

3 EXECUTION

3.01 GENERAL RE: INSTALLATION OF CONDUIT

- .1 Refer to the article entitled General Conduit and Conductor Installation Requirements in the electrical work Section entitled Basic Electrical Materials and Requirements.
- .2 Ensure that all open empty conduit ends are properly protected against dirt and debris during the construction process.

3.02 CONDUIT INSTALLATION REQUIREMENTS

- .1 Unless otherwise specified, provide conduit for all conductors except armoured cable, mineral insulated fire rated cable, and except where cable tray, cable duct, or a similar raceway is used.
- .2 **Conduit Types:** Conduit is to be as follows:
 - .1 for main distribution wiring in electrical rooms and similar areas – rigid galvanized steel
 - .2 for exposed conduit from floor level to 1.2 m (4") above the floor in mechanical and other service rooms – rigid galvanized steel
 - .3 for concealed conduit in exterior walls – rigid galvanized steel
 - .4 for explosion-proof wiring – rigid galvanized steel
 - .5 for conduit exposed outside the building, except where rigid PVC conduit is permitted – rigid galvanized steel
 - .6 for conduit associated with pool area outlets but not submerged in water – rigid galvanized steel
 - .7 as an alternative to rigid galvanized steel, except in poured concrete construction – rigid aluminium conduit
 - .8 for conduit in corrosive areas – epoxy coated rigid galvanized steel

- .9 for short (minimum 450 mm (18"), maximum 600 mm (24"), with a 180° loop wherever possible) runs of conduit to electric motors, distribution transformers, and vibration isolated equipment – flexible galvanized steel liquid-tight conduit
- .10 at points where exposed conduit crosses building expansion joints – flexible galvanized steel conduit
- .11 for branch circuit conductors underground inside the building, and underground outside the building beneath structures and concrete or asphalt paving – rigid PVC
- .12 for branch circuit conductors outside the building at roof level – rigid PVC
- .13 for branch circuit conductors in concrete slabs on grade, and in concrete and masonry walls except exterior walls - rigid PVC
- .14 for branch circuit conductors in concrete slabs above grade – flexible PVC
- .15 for underwater conduit – rigid bronze
- .17 for all conduit except as specified above – EMT
- .18 communications/security systems conductors – EMT
- .3 **Conduit Fittings:** Unless otherwise specified, conduit fittings are to be of the same material as the conduit and suitable in all respects for the application. Provide proper adaptors for joining conduit of different materials.
- .4 **Conduit Bends:** Site made bends for conduit must be made using proper bending equipment, bends must maintain the full conduit diameter with no kinking, and conduit finishes and lining must not flake or crack when the conduit is bent.
- .5 **Site Cutting Conduit:** Cut square and ream all site cut conduit ends.
- .6 **Conduit Threads:** Site cut rigid steel conduit using proper thread cutting equipment, in an approved area. Protect the area and building surfaces from being soiled/damaged by the threading process. Clean and lubricate threads and coat threads with red lead or other zinc rich coating.
- .7 **Conduit Sizes:** Generally, conduit is sized on the drawings. Conduit not sized on the drawings is to be sized in accordance with the governing Codes/Regulations. The sizes of branch circuit conductors shown/specified are minimum sizes and must be increased to suit length of run and voltage drop, and where this occurs, increase the conduit size to suit. Do not use conduit less than 15 mm (½") diameter.
- .8 **Empty Conduit:** Ensure that all conduit left empty for future wiring is clean, capped, and properly identified. Provide end bushings and fish cord in all such conduit.
- .9 **Empty Conduit At Panelboards:** Where a suspended ceiling occurs, provide 4, empty, 20 mm (¾") diameter conduits from each flush wall mounted panelboard terminated in the suspended ceiling above, capped and identified.

3.03 CONDUIT INSTALLED IN POURED CONCRETE

- .1 Where conduit is to be embedded in structural poured concrete, obtain the Consultant's approval. Submit a drawing indicating the location and size of the conduit, the length of run, and any other required details. Obtain the Consultant's written approval prior to conduit installation. The Consultant's decision regarding conduit in structural poured concrete is final and is not the basis of a claim for additional costs.
- .2 When and where conduit is permitted in structural poured concrete, abide by the following requirements:
 - .1 install the conduit in accordance with requirements of CAN/CSA-A23.1, Concrete Materials and Methods of Concrete Construction
 - .2 the conduit must be secured in a manner such that the conduit will not be displaced when the concrete is poured, and during the concrete pour, monitor the conduit installation to prevent displacement or damage, and immediately report any misplacement or damage observed
 - .3 where conduit extends adjacent to a column, stay away from the column a minimum of 2 times the thickness of the slab and drop away from the column
 - .4 where conduits terminate adjacent to a column or wall, bring the conduit in toward the column/wall as close to 90° to the face of the column/wall as possible
 - .5 where more than 2 conduits are adjacent to each other they are to be spaced the greater of 3 conduit diameters or 100 mm (4") apart
 - .6 place conduit in the middle third of the slab thickness, and do not in any case lay conduit directly on reinforcing steel
 - .7 do not locate conduit adjacent to parallel reinforcing bars
 - .8 the maximum size of any conduit is 1/5th of slab thickness
 - .9 do not install conduit longitudinally in a beam without specific approval of the Consultant, and extend conduit through a beam at right angles to the beam span
 - .10 where conduits extend through beams stay a minimum of twice the depth of the beam away from the supports
 - .11 do not install conduit in the slab beside a drop or beam within twice the depth of the slab from the edge of the drop or beam
 - .12 do not install conduits through shear walls or columns without written approval from the consultant
 - .13 do not install conduit in parking garage structures, garage ramps, water retaining structures, or any other concrete subject to the application of de-icing products
 - .14 in areas where installation of conduit embedded in concrete is not permitted, extend

conduit through beams in sleeves, if the installation of the sleeves is permitted

- .15 slope all underground conduit to drainage points and ensure that the conduit can be drained

3.04 CONDUIT UNDER SLAB ON GRADE

- .1 Where conduit is to be installed under a slab on grade, the system is to be a pull-in system, must consider and address any effects of magnetic fields, and the following is to apply:
 - .1 concrete encased duct bank with non-ferrous conduits is to be used
 - .2 conduit is to be sloped to a proper drainage pit
 - .3 20% spare conduit (minimum 1) is to be provided

3.05 SEALED CONDUIT PENETRATIONS

- .1 For isolation rooms, any conduit penetration any surface of the room is to be sealed with a suitable elastomeric and intumescent material to ensure complete isolation of the room/area. The sealing material must be non-hazardous and suitable in all respects for the specific application, including a fire rating if required. Submit product data for the proposed sealing material as well as WHMIS sheets and product installation instructions

3.06 CONDUIT SUPPORT

- .1 **Underground Conduit:** Unless otherwise shown or specified, support underground conduit on a well tamped bed of earth or sand, free from rocks or protrusions of any kind.
- .2 **Surface Mounted & Suspended Single/Double Conduit Runs:** Support and secure single and double runs of conduit at support spacing in accordance with Code requirements by means of galvanized steel pipe straps, conduit clips, ring bolt type hangers with galvanized steel hanger rods, or by other approved manufactured devices.
- .3 **Support of Multiple Conduit Runs:** Support multiple conduit runs by means of Electrovert Ltd. "CANTRUSS" or Burndy Ltd. "FLEXIBLE" conduit racks and galvanized steel rods with support spacing to suit requirements of the smallest diameter conduit in the group or approved equivalent.
- .4 **Conduit Expansion Facilities:** Abide by the following:
 - .1 wherever concealed or surface mounted conduit extends across a building expansion joint, provide expansion facilities to permit free movement without imposing additional stress or loading on the support system, and to prevent excessive movement at joints and connections
 - .2 provide manufactured expansion joint fittings in rigid PVC conduit at spacing recommended by the expansion joint fitting manufacturer
 - .3 make "snaked" bends in underground flexible polyethylene conduit

End of Section

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for all products specified in this Section.
- .2 **Colour Chart:** Submit a colour chart with product data and do not order raceway until the colour selection has been confirmed by the Consultant.

1.02 QUALITY ASSURANCE

- .1 Wireways and auxiliary gutters are to be in accordance with requirements of CAN/CSA C22.2 No. 26, Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings.

2 PRODUCTS

2.01 WIREWAYS AND GUTTERS

- .1 Wireways and gutters are to be of sheet steel construction with no sharp edges, sized for the wiring as required and/or indicated, complete with all required fittings and accessories, and a baked grey enamel finish. Covers are to be hinged and bolted to give uninterrupted access to wiring.

3 EXECUTION

3.01 INSTALLATION OF WIREWAYS AND GUTTERS

- .1 Provide wireway/gutters where shown. Confirm exact locations and routing prior to installation. Provide supports, fittings, adaptors, and accessories as required but keep the number of elbows, offsets, and connections to the minimum.
- .2 Provide barriers in wireways/gutters where different voltage wiring is required.
- .3 Install gutter to full length of equipment.
- .4 Identify wireways/gutters with engraved nameplates as specified in the Section entitled Basic Electrical Materials and Methods.

End of Section

GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for wiring devices. Ensure that the sheets indicate colours and faceplate finishes.
- .2 **Wiring Device Samples:** Submit identified samples in original packaging of the following wiring devices:

1.02 QUALITY ASSURANCE

- .1 All wiring devices are to be CSA certified as a minimum, in accordance with the following standards, as applicable:
 - .1 CAN/CSA C22.2 No. 42, General Use Receptacle, Attachment Plugs and Similar Wiring Devices
 - .2 CAN/CSA C22.2 No. 42.1, Cover plates for Flush Mounted Devices
 - .3 CSA C22.2 No. 111, General Use Snap Switches
- .2 Wherever possible, all wiring devices are to be supplied by the same manufacturer.
- .3 **Acceptable Manufacturers:** Unless otherwise specified in this Section or on the drawings, acceptable manufacturers are:
 - .1 Hubbell Canada LP
 - .2 Cooper Industries (Arrow Hart)
 - .3 Legrand/Pass & Seymour
 - .4 Leviton Canada
 - .5 Pass & Seymour
 - .6 Approved Equivalnet.

1.03 WIRING DEVICE AND PLATE COLOURS

- .1 Unless otherwise specified, wiring device colours will be as specified in Part 3 of this Section.

2 PRODUCTS

2.01 SWITCHES

- .1 Unless otherwise specified, Specification Grade, Premium Quality, back and side wired, 20 ampere, 120-277 volt A.C. quiet action toggle switches, single pole, 2-pole, 3-way, or key type as indicated on the drawings, each complete with a nickel plated steel ground terminal, brass power wiring terminals and screws, silver cadmium oxide contacts with a moveable brass contact arm, and nylon toggle with colour as specified below. Switch types are as follows:

- .1 **Standard Wall Toggle Switches:** As above.
- .2 **Illuminated Handle Standard Wall Toggle Switch:** As above for standard switches but with a clear red or green polycarbonate toggle which is illuminated when the switch is on or off. Confirm toggle colour and position when illuminated prior to ordering.
- .3 **Decorative Wall Rocker Switch:** Generally as specified above for standard toggle switches but rectangular decorative rocker type with rocker handles.
- .4 **Illuminated Decorative Wall Rocker Switch:** Generally as specified above for decorative toggle switches but with a rocker type illuminated handle.
- .5 **Door Switch:** Box, switch and plate assemblies with a 125 volt 3 ampere illuminated switch which is on or off when the door is open (confirm prior to ordering), a 34 mm x 94 mm x 40 mm (1 11/32" x 3 11/16" x 1 1/2") box, cover plate, and mounting screws.
- .6 **Hazardous Location Switch:** Explosion-proof, surface mounting, front operated switches suitable for use in Class 1 Division 2 locations with exact classification and configuration to suit the mounting location and the equipment the switch is provided for.
- .7 **Motor Control Snap Action Switch:** Illuminated handle snap action horsepower rated switch, CSA certified for motor control and sized to suit the application.
- .8 **Occupancy Sensor Switch:** Digital ultrasonic sensor type, 120-277 volt A.C. with integral photo sensor and selected to suit the area and occupancy of the room served.

2.02 SPECIFICATION GRADE STANDARD RECEPTACLES

- .1 Back or side wired, U-ground, 2 pole receptacles as follows:
 - .1 **15 Amp. 125 Volt Duplex Receptacle:** 3-wire receptacles, NEMA configuration 5-15R
 - .2 **15 Amp. 250 Volt Duplex Receptacle:** 3-wire receptacles, NEMA configuration 6-15R
 - .3 **20 Amp. 125 Volt Duplex Receptacle:** 3-wire receptacles, NEMA configuration 5-02R
 - .4 **20 Amp. 250 Volt Duplex Receptacle:** 3-wire receptacles, NEMA configuration 6-20R
 - .5 **30 Amp. 250 Volt Simplex Receptacle:** 3-wire receptacles, NEMA configuration 6-30R
 - .6 **30 Amp. 125/250 Volt Simplex Receptacle:** 3-wire receptacles, NEMA configuration 14-30R
 - .7 **50 Amp. 250 Volt Simplex Receptacle:** 3-wire receptacles, NEMA configuration 6-50R

- .8 **50 Amp. 125/250 Volt Simplex Receptacle:** 4-wire receptacles, NEMA configuration 14-50R

2.03 SPECIFICATION GRADE LOCKING RECEPTACLES

- .1 Specification Grade, back or side wired, U-ground 2-pole, 3-wire locking type receptacles as follows:
 - .1 **15 Amp. 125 Volt Duplex Receptacle:** NEMA configuration L6-15R
 - .2 **15 Amp. 250 Volt Duplex Receptacle:** NEMA configuration L6-15R
 - .3 **20 Amp. 125 Volt Duplex Receptacle:** NEMA configuration L5-20R
 - .4 **20 Amp. 250 Volt Duplex Receptacle:** NEMA configuration L6-20R

2.04 SPECIFICATION GRADE GROUND FAULT RECEPTACLES

- .1 Heavy-duty, 15/20 ampere, 125 volt, ULC Class A, Group 1. automatic ground fault circuit interrupting duplex receptacles with a 10 kA short circuit current rating automatic self-test diagnostics, green power on LED, and red ground fault LED. Ground fault receptacles for indoor climate controlled and outdoor or non-climate controlled areas are to be as follows:
 - .1 indoor climate controlled areas: equal to Hubbell Canada No. GFST15/GFSTt20 "AUTOGUARD"
 - .2 outdoor areas and indoor non-climate areas: equal to Hubbell Canada No. GFR5262TR/GFR 4362TR "AUTOGUARD"

2.05 EXPLOSION-PROOF RECEPTACLES

- .1 Equal to Cooper Crouse-Hinds ENR Series "Ark-Gard" dead front, simplex, interlocking circuit breaking receptacles suitable for installation Class 1 Division 1 and 2 explosion- proof receptacles, 15 ampere or 20 ampere, 125 volt or 250 volt as indicated on the drawings, each complete with a die-cast copper-free aluminium housing and spring door with stainless steel hinge and neoprene gasket, and fiberglass reinforced polyester receptacle.

2.06 SPECIFICATION GRADE TAMPER-RESISTANT DUPLEX RECEPTACLES

- .1 Specification Grade, back or side wired, U-ground, 2-pole, 3-wire tamper-resistant duplex receptacles as specified above, 15 ampere or 20 ampere, 125 volt as indicated on the drawings, each with thermoplastic shutters to limit access to energized contacts.

2.07 CLOCK HANGER RECEPTACLES

- .1 Equal to Legrand/Pass & Seymour #S3713W 15 ampere, 125 volt white recessed simplex receptacle with smooth white wall plate.

2.08 PHOTO ELECTRIC SWITCH

- .1 Equal to Tork 2100 Series weather-proof, 12 mm (½") dia. conduit mounting photoelectric SPST control switch with model number to suit the voltage and connected load, complete with an adjustable slide for on-off adjustment, a turn-on of one to five fc and a turn-off of three to five fc without the slide in position, a die-cast zinc gasketed enclosure, cadmium sulphide epoxy coated cell, normally closed contacts which fail in the open position, a delay of up to four minutes to prevent false switching due to light from vehicles, lightning, etc., three colour coded 150 mm (6") # 16 AWG leads, a fixed base for conduit connection, and, if required, an accessory bracket for wall mounting the device.

2.09 TIME SWITCH

- .1 Flush wall mounting spring wound ivory time switch with matching faceplate, equal to Tork A500 Series with exact catalogue number to suit the connected load.

2.10 DEVICE FACEPLATES

- .1 Device faceplates are to be ULC listed and CSA certified and, unless otherwise specified, supplied by the device manufacturer. Where two or more devices are installed in a common box, a common one-piece faceplate is to be used. Faceplate colours are specified in Part 3. Faceplates, unless otherwise specified, are to be as follows:
 - .1 type 302 stainless steel switch and receptacle faceplates, brush finish or satin finish as directed, with stainless steel screws
 - .2 high impact smooth finish switch and receptacle faceplates
 - .3 hot dipped galvanized steel switch and receptacle faceplates
 - .4 NEMA 3 rated, single gang, horizontal/vertical mounting, weather-proof in use, gasketed cast aluminium, receptacle faceplates to suit the type of receptacle used
 - .5 weather-proof, gasketed, water-tight single gang type 302 stainless steel switch plate with clear silicone rubber bubble over the switch toggle

3 EXECUTION

3.01 GENERAL RE: INSTALLATION OF WIRING DEVICES

- .1 Provide all required wiring devices and faceplates
- .2 Confirm exact locations, including mounting heights prior to roughing-in.
- .3 For barrier-free mounting heights for devices, conform to requirements of the governing code or regulation.
- .4 Ensure that switches located adjacent to doors are located at the strike side of the door.

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- Confirm door swings prior to roughing-in.
- .5 Install single throw switches with the handle in the up position when the switch is closed.
 - .6 Confirm all switch, receptacle and faceplate types, colours and finishes prior to ordering
 - .7 Provide a separate insulated ground conductor for each isolated ground receptacle.
 - .8 Faceplates for computer equipment receptacles are to be permanently identified with "Computer Equipment Only" wording.
 - .9 Faceplates for housekeeping receptacles are to be permanently identified with "Housekeeping Only" wording.
 - .10 Do not install faceplates for flush devices until wall, etc., finishing work is complete
 - .11 Where devices are to be installed in casework, millwork, or similar construction, carefully coordinate device installations and device openings with the trade providing the casework, millwork, etc.
 - .12 Device locations indicated on the drawings are approximate, and, if requested, relocate the device up to 3 mm (10') away from the location shown at no additional cost.
 - .13 All receptacles within 1.5m of a sink or shower/tub are to be GFCI type.
 - .14 Label all receptacles and light switches with panel & circuit number. Use clear P-Touch label or approved equivalent with black letters.

3.02 WIRING DEVICE AND FACEPLATE TYPES AND COLOURS

- .1 Unless otherwise specified, wiring devices colours and faceplate types and colours are to be as follows:

standard switches & receptacles in finished areas – stainless steel faceplates

- .1 **"Decorator" switches & receptacles in finished areas** – stainless steel faceplates
- .2 **switches & receptacles in finished areas:** stainless steel faceplates
- .3 **switches & receptacles in unfinished areas-non-essential circuits:** stainless steel faceplates or hot dipped galvanized
- .4 **weather-proof switches:** weather-proof stainless steel faceplates with clear silicone bubble over the switch toggle

3.03 TESTING

- .1 When installation is complete, test operation of all devices.

End of Section

PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS

- .1 Read and be governed by conditions of the *Contract Documents*, including sections of Division 1.

1.2 APPLICABLE STANDARDS

- .1 Applicable Standards are listed below:
 - .1 ASHRAE Standard 202-2024 - The Commissioning Process Requirements for New Buildings and New Systems
 - .2 ASHRAE Standard 230-2022 - Commissioning Process for Existing Buildings and Systems
 - .3 ASHRAE Guideline 0-2019 - the Commissioning Process
 - .4 ASHRAE Guideline 0.2-2015 - Commissioning Process for Existing Systems and Assemblies
 - .5 ASHRAE Guideline 1.1-2025 - Application of the Commissioning Process to New HVAC&R Systems
 - .6 ATSM E2813 – Standard Practice for Building Enclosure Commissioning
 - .7 ATSM E2947 – Standard Guide for Building Enclosure Commissioning
 - .8 CaGBC LEED v4.1 Building Design and Construction Reference Guide
 - .1 LEED EAp1: Fundamental Commissioning and Verification
 - .2 LEED EAc1: Option 1. Path 1: Enhanced Commissioning
 - .9 CSA Z320-11 Building Commissioning Standard & Check Sheets
 - .10 CSA C282-15 – Emergency Power Supply for Buildings
 - .11 NIBS Guideline 3-2012 – Building Enclosure Commissioning Process

1.3 GENERAL

- .1 The purpose of this section is to specify Division 26 responsibilities in the commissioning process.
- .2 Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 26 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.4 SYSTEMS TO BE COMMISSIONED

- .1 Systems to be commissioned as part of this contract include, but may not be limited to the following:
 - .1 Electrical, including service, distribution, lighting and controls including daylighting controls
 - .2 Applicable meters

1.5 COMMISSIONING TEAM

- .1 The Commissioning Team shall consist of representatives of the following as appropriate:

- .1 Owner and the Owner's FM Staff
- .2 Consultant
- .3 Commissioning Authority (CxA)
- .4 General Contractor (GC)
- .5 Subcontractors (Mechanical, Electrical, Controls, TAB)
- .6 Specialized third-party for verification

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 COMMISSIONING AUTHORITY RESPONSIBILITIES

- .2 The Commissioning Authority shall:
 - .1 Plan, organize and implement the commissioning process as specified herein;
 - .2 Prepare the commissioning plan, ensure its distribution for review and comment;
 - .3 Revise the commissioning plan as required during construction;
 - .4 Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;
 - .5 In conjunction with the GC, coordinate commissioning activities;
 - .6 Monitor system verification checks, and ensure the results are documented as the checks are done;
 - .7 Observe select start-ups and initial system operations tests and checks;
 - .8 Develop Functional Test scripts
 - .9 Direct the GC to operate equipment and systems as required to ensure that all required functional performance tests are carried out for verification purposes;
 - .10 Witness functional performance tests and document the results;
 - .11 Prepare and submit a commissioning report which documents all checks and tests done throughout the commissioning process, and the results obtained from each;
 - .12 Ensure all required O&M manuals, instructions and demonstrations are provided to the Owner's designated facility operating staff.

3.2 CONSULTANT RESPONSIBILITIES

- .1 The Consultant commissioning responsibilities are outlined below:
 - .1 Review the commissioning plan, proposed test procedures, and participate (as appropriate) in on-site commissioning meetings.
 - .2 At their discretion during the acceptance phase of the commissioning process, be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance

3.3 OWNER/ PROJECT MANAGER RESPONSIBILITIES

- .1 The Owner shall have the following commissioning responsibilities
 - .1 Ensure the availability of facility operations staff for all scheduled instructions and demonstration sessions (training).
 - .2 At their discretion, witness commissioning performance tests.

3.4 SUBCONTRACTOR RESPONSIBILITIES

- .1 The Contractor shall ensure that the Subcontractor complies with all requirements included in this Section and fulfills the following responsibilities during construction and acceptance phases in addition to those listed above are (all references apply to commissioned equipment only)
 - .1 Documentation of all procedures performed shall be provided and forwarded to the engineer. Written documentation must contain recorded test values of all electrical tests performed per the individual product specification.
 - .2 The start-up service company shall be present during energization of the electrical equipment. Jobsite and equipment access must be provided by the Electrical Subcontractor.
 - .3 The Contractor shall supply a power source, specified by the start-up service company, for on-site test equipment.
 - .4 The subcontractor is to attend all factory witness testing required within the respective specification sections. All costs associated with the electrical system commissioning specified in this Section shall be included in the bid price.
 - .5 Perform tests using qualified personnel. Provide necessary instruments and equipment.
 - .6 Include the cost of commissioning in the contract price, if not yet let.
 - .7 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
 - .8 Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
 - .9 Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of pre-functional and functional testing procedures.
 - .1 Typically, this will include detailed manufacturer 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. In addition, the installation and checkout materials that are 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 Commissioning Authority.
 - .2 The Commissioning Authority may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
 - .10 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CxA for review.

- .11 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- .12 Provide assistance to the CxA in preparation of the specific functional performance test procedures specified in Division 26. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- .13 Develop a full start-up and checkout plan using manufacturer's start-up procedures and the pre-functional test sheets from the CxA. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CxA for review.
- .14 During the startup and checkout process, execute and document the electrical-related portions of the pre-functional test sheets provided by the CxA for all commissioned equipment.
- .15 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
- .16 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. 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.
- .17 Perform functional performance testing under the direction of the CxA for specified equipment of this section (Section 26 08 00). Assist the CxA in interpreting the monitoring data, as necessary.
- .18 Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC and Consultant and retest the equipment.
- .19 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- .20 During construction, maintain as-built red-line drawings for all drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings.
- .21 Provide training of the Owner's operating personnel as specified.
- .22 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- .23 Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
- .24 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

3.5 SUBMITTALS

- .1 Division 26 Contractors shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 01 91 00 for additional Division 26 requirements.

3.6 START-UP OF EQUIPMENT

- .1 The GC shall ensure the Electrical Contractors follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in Section 01 91 00, Part 3.10. Section 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA or Owner.
- .2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA, Consultant and GC. Beginning system testing before full completion, does not relieve the Subcontractor from fully completing the system, including all Pre Functional test sheets as soon as possible.
- .3 All equipment shall be started by the Manufacturer's representative.

3.7 PRE-FUNCTIONAL TEST SHEETS

- .1 Pre-functional test sheets contain items for Division 26 Contractors to perform. On each checklist, a column is provided that is to be completed by the GC assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.
- .2 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout. Items that do not apply should be noted along with the reasons on the form. If this form is not used for documenting, one of similar rigor and clarity shall be used pending approval from the CxA.

3.8 FUNCTIONAL TESTING, DOCUMENTATION, NON-CONFORMANCE AND ACCEPTANCE

- .1 Refer to Specification 01 91 00 for more information in addition to this 26 08 00.

3.9 OPERATION AND MAINTENANCE MANUALS

- .1 Division 26 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 26 and deliver to the GC for inclusion in the O&M manuals.
- .2 ASHRAE Guideline 4-2008 is the recommended format.
- .3 The CxA shall receive a copy of the O&M manuals for review.

3.10 TRAINING OF OWNER PERSONNEL

- .1 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 00 for additional details.
- .2 The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 00 for additional details.
- .3 The Electrical Subcontractor shall have the following training responsibilities:

- .1 Provide the CxA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.14.
- .2 Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical 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 startup, 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 person may be the start-up technician for the piece of equipment, the installing subcontractor 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 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - .2 Include a 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, shut-down, seasonal changeover and any emergency procedures.
 - .3 Discuss relevant health and safety issues and concerns.
 - .4 Discuss warranties and guarantees.
 - .5 Cover common troubleshooting problems and solutions.
 - .6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - .7 Discuss any peculiarities of equipment installation or operation.
- .8 Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
- .9 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
- .10 The Electrical Subcontractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- .11 Training shall occur after functional testing is complete, unless accepted otherwise by the Consultant and/or Owner/Project Manager.

3.11 DEFERRED TESTING

- .1 Refer to Section 01 91 00, Part 3.15 for requirements of deferred testing.

3.12 WRITTEN WORK PRODUCTS

- .1 Written work products of Section 26 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets. Refer to Section 01 91 00 Part 3.16.

END OF SECTION

GENERAL

1.01 REFERENCES

- .1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE).
- .2 Underwriters Laboratories of Canada (ULC)
- .3 International Electrotechnical Commission
- .4 International Organization for Standardization (ISO)
- .5 National Electrical Manufacturers Association (NEMA)

1.02 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for occupancy sensors.
- .2 Submit composite wiring diagrams and control schedule for each room control circuit type as proposed to be installed. Include load type, sequence of operation, sensor parameters, time delays, sensitivities and daylighting set points.

1.03 MOCK-UP

- .1 Include for providing a sensor mock-up installation in a typical washroom to verify proper operation prior to installation of other sensors.

1.04 SCOPE

- .1 This contractor is responsible to supply and install all equipment and control wiring as specified for the digital occupancy and daylight control systems. This contractor must coordinate these control systems with the lighting fixtures being supplied for the project to ensure intended function as specified.
- .2 Control Intent: Control Intent includes, but is not limited to:
 - .1 Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
 - .2 Initial sensor and switching zones
- .3 All equipment must be CSA approved or approved at this contractor's expense by the Special Inspection Division of the Electrical Safety Authority

1.05 SYSTEM DESCRIPTION

- .1 Permanently installed
 - .1 Wall switch occupancy sensors
 - .2 Ceiling mounted occupancy sensors

- .3 Switch packs (relays)

1.06 WARRANTY

- .1 Provide a five (5) years complete manufacturer's warranty on ALL products to be free of manufacturer's defects.

1.07 QUALITY ASSURANCE

- .1 Manufacturer: Minimum five (5) years' experience in manufacture of lighting controls
- .2 All occupancy sensors are to be solid-state design, UL/ULC listed and labelled and CSA certified in accordance with CAN/CSA C22.2 No. 184, Solid-State Lighting Controls, and designed specifically for energy conservation.
- .3 Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who is specialized in installation of work similar to that required for this project.
- .4 Source Limitations: To assure compatibility, obtain occupancy sensors from a single source with complete responsibility over all lighting controls, including accessory products. The use of subcontracted component assemblers is not acceptable.

1.08 ACCEPTABLE MANUFACTURERS:

- .1 Basis of design product: Eaton Lighting Systems (formerly Cooper Controls-Greengate).
- .2 Equal manufactured by one of the following:
 - .1 Hubbell Control Solutions
 - .2 Watt Stopper/Legrand
 - .3 Lutron Electronics Co. Inc.
 - .4 Leviton Manufacturing Co. Inc.
- .5 Approved Equivalent

2 PRODUCTS

2.01 SENSORS

- .1 Sensing mechanism:
 - .1 Infrared – utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
 - .2 Ultrasonic
 - .1 Utilize and operating frequency of 32 kHz or 40 kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
 - .2 Utilize Doppler shift ultrasonic detection technology

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- .3 Dual technology
 - .1 Utilize multiple segmented lens, with internal grooves to eliminate dust and residual build-up
 - .2 Utilize and operating frequency of 32 kHz or 40 kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
 - .3 Incorporate Doppler shift ultrasonic and passive infrared motion detection technologies. Products to react to noise and ambient sound shall not be considered.
 - .2 Power failure memory:
 - .1 Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.
 - .3 Designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.
 - .4 Products tested in identical manner, compliant to NEMA WD 7-2011 Occupancy Motion Sensor Standards.
 - .5 Sensors shall have time delays from 5 to 30 min
 - .6 When specified, sensors shall automatically adjust time delay and sensitivity settings
 - .7 All sensors shall provide an LED as visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
 - .8 All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
 - .9 Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified unit to achieve this function are NOT acceptable.

2.02 LOW VOLTAGE CEILING MOUNTED VACANCY AND OCCUPANCY SENSORS

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Sensors shall be Class 2 devices
- .4 When requested, be able to provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology.
- .5 When requested on drawings, provide an internal additional isolated relay with Normally Open, Normally Closed outputs for use with HVAC control, Data Logging and other control options.

2.03 LINE VOLTAGE CEILING MOUNTED OCCUPANCY SENSORS

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Provide a mechanical air-gap on/off function for all sensors
- .4 Capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet
- .5 Shall accommodate loads from 0-800 watts at 120 volts and shall have a minimum 180 degree coverage capability.
- .6 Shall be able to have their visible plastic parts replaced, for colour changes in the field, without removing the body of the control from the wall and without requiring special tools.
- .7 Shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
- .8 Shall have no leakage current to load, in manual or in Auto/Off Mode for safety purposes and shall have voltage drop protection.
- .9 Where specified, sensors shall offer daylighting foot-candle adjustment control and be able to accommodate dual level lighting.
- .10 Where specified, dual relay sensors shall offer daylighting foot-candle adjustment control for either or both relays.
- .11 Where specified, dual relay sensors shall offer a Bathroom Mode which keeps the second relay ON for an addition 8 minutes after the first relay has been turned off.
- .12 Sensor packaging shall be 100% recycled as well as 100% recyclable.
- .13 Sensors shall be RoHS (Restriction of Hazardous substances) compliant
- .14 Where specified, sensors shall offer integral Bi-level Automatic On (just one lighting level comes on automatically when occupancy is detected)

2.04 WALL/CORNER MOUNTED SENSORS

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Sensors shall be Class 2 devices
- .4 When requested on drawings, provide an internal additional isolated relay with Normally Open, Normally Closed outputs for use with HVAC control, Data Logging and other control options
- .5 Where specified, sensors shall offer daylighting footcandle adjustment control
- .6 Sensor packaging shall be 100% recycled as well as 100% recyclable.

- .7 Sensors shall be RoHS compliant.
- .8 Where specified, sensors shall offer integral Bi-level Automatic On (just one lighting level comes on automatically when occupancy is detected).

2.05 VACANCY OR OCCUPANCY WALL SWITCHES

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Requires Manual On to activate lighting (Vacancy Sensor only)
- .4 Cannot be modified to provide Automatic ON capabilities (Vacancy Sensor only)
- .5 Provide a mechanical air-gap on/off function for all sensors
- .6 Capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet
- .7 Shall accommodate loads from 0-800 watts at 120 volts and shall have 180 degree coverage capability.
- .8 Shall be able to have their visible plastic parts replaced, for colour changes in the field, without removing the body of the control from the wall and without requiring special tools.
- .9 Shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
- .10 Shall have no leakage current to load, in manual or in Auto/Off Mode for safety purposes and shall have voltage drop protection.
- .11 Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from Automatic On to Manual On.
- .12 Where specified, sensors shall offer daylighting foot-candle adjustment control and be able to accommodate dual level lighting.
- .13 Where specified, dual relay sensors shall offer daylighting foot-candle adjustment control for either or both relays.
- .14 Where specified, dual relay sensors shall offer a Bathroom Mode which keeps the second relay On for an addition 8 minutes after the first relay has been turned off.
- .15 Where specified, sensors shall feature a universally recognized light bulb icon for end user ease of identification of use.
- .16 Where specified, dual relay sensors shall feature universally recognized light bulb and fan icons for end user ease of identification of use.
- .17 Sensor packaging shall be 100% recycled as well as, 100% recyclable.

- .18 Sensors shall be RoHS compliant.
- .19 Where specified, sensors shall have an EcoMeter that provides a visual indicator of energy usage, increasing end user awareness and reminding individuals to take control of their lighting to maximize energy savings.
- .20 Where specified, low voltage sensors shall have a Tracking/HVAC Mode that allows the load connected to the Form C BAS relay to remain on when the lights are turned off manually.
- .21 Where specified, sensors shall have a tamper-proof Automatic Only Mode that automatically turns lighting ON and OFF without requiring a user to push a button

2.06 SENSOR SWITCHPACK

- .1 Product: provide switchpack as required for low voltage sensors to suit and shall be of same manufacturer
- .2 Control wiring between sensors and control units shall be Class 2, 18-24 AWG, stranded U.L. Classified.
- .3 Integrated, self-contained unit consisting internally of an isolated load switching control relay and a power supply to provide low voltage power.
- .4 Shall be compatible with incandescent, magnetic or electronic low voltage, and magnetic or electronic fluorescent, as well as motor loads.

2.07 LOW TEMPERATURE SENSOR

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Sensors shall be Class 2 devices
- .4 Provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology.
- .5 When requested on drawings, provide an internal additional isolated relay with Normally Open, Normally Closed outputs for use with HVAC control, Data Logging and other control options

2.08 DIGITAL TIME SWITCHES

- .1 Product: TSM-MV or approved equivalent.
- .2 Provide all necessary mounting hardware and instructions.

2.09 SOURCE QUALITY CONTROL

- .1 Perform full-function testing on 100% of all system components and panel assemblies at the factory.

3 EXECUTION

3.01 INSTALLATION OF OCCUPANCY SENSORS

- .1 Install in accordance with manufacturer's printed instruction unless noted otherwise.
- .2 When using wire for connection other than the digital local network (Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colours to simplify contractor termination requirements
- .3 Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings
 - .1 Adjust time delay so that controller area remains lighted for predetermined time as outlined on drawing schedule after occupant leaves area. If time is not indicated on drawing schedules set for 5 minutes.
 - .2 Program all room control systems to function in vacancy mode. User must manually turn lighting on with automatic delay to off.
- .4 Install power packs in accessible maintenance areas unless noted otherwise. Provide access doors if power packs are installed above drywall ceilings.
 - .1 Provide power packs for 24 volt DC sensors and locate where accessible for maintenance. Ensure that panelboard breakers serving power packs are equipped with lock-on devices. Unless otherwise indicated install power packs in 150 mm x 150 mm x 100 mm (6" x 6" x 4") utility boxes painted white and identified with a Lamacoid nameplate, and connect to sensors with armoured cable with 1.5 m (5") of slack cable for location adjustment if required.
- .5 Provide occupancy sensors, generally where shown but with exact locations in accordance with reflected ceiling plans and the sensor manufacturer's instructions. Include for all required site assembly, and provide all required installation and support hardware.
- .6 It shall be contractor's responsibility to locate and aim sensors in the correct location required for complete and proper coverage within the range of coverage as per manufacturer's recommendations. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective rooms.
- .7 Confirm exact locations prior to roughing-in.
- .8 Connect sensors to circuits indicated with wiring in conduit.
- .9 Provide computer generated documentation on the commissioning of the system including room by room description including;
 - .1 Sensor parameters, time delays, sensitivities and daylighting setpoints
 - .2 Sequence of operation, (eg. Manual ON, Auto OFF, etc.)
 - .3 Load Parameters (eg. Blink warning, etc.)

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- .10 Re-commissioning – after 30 days from occupancy re-calibrate all sensor time delays and sensitivities to meet the Owner's Project Requirement. Provide a detailed report to the Architect/Owner of re-commissioning activity.
 - .11 Assist the Owner's operating personnel in the location and adjustment of sensors to suit the location and application.
 - .12 Include for a 4 hour on-site training session for the Owner's personnel to demonstrate operation and adjustments of sensors, and trouble-shooting procedures.

3.02 FACTORY COMMISSIONING

- .1 Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system
- .2 The electrical contractor shall provide both the manufacturer and the electrical Engineer with ten (10) working days written notice of the system start-up and adjustment date.
- .3 Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.
- .4 Factory commission shall include functional testing and documentation of the control system conforming to ASHRAE 9.4.4. This cost shall be included in the Tender Price.
- .5 Include for the following manufacturer representative site visits:
 - .1 Pre-wiring visit
 - .2 System set-up visit
 - .3 Third party ASHRAE functional testing visit
 - .4 System commissioning visit

End of Section

1 GENERAL

1.01 SUBMITTALS

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for all equipment specified in this Section. Both shop drawings and product data sheets must confirm that the equipment proposed meets all requirements of the Contract Documents. Shop drawings/product data is to include:
 - .1 equipment dimensions and details
 - .2 a single line diagram and a schematic diagram, if applicable
 - .3 component nameplate and warning sign data
 - .4 short circuit ratings, voltage ratings, continuous current ratings, and interrupt ratings
 - .5 any additional information requested by the Consultant
- .2 **Test Reports:** Submit signed copies of all test reports, and include a copy of each report with O & M Manual project close-out data.
- .3 **Spare Fuses:** Submit as specified in Part 3 of this Section.
- .4 **Manufacturer's Installation Certification Letter:** Submit a service entrance board manufacturer's installation certification letter as specified in Part 3 of this Section.

2 PRODUCTS

2.01 FUSED DISCONNECT SWITCH

- .1 In accordance with Section 26 28 23, Disconnect Switches, with rating as indicated on the drawings.

2.02 ENCLOSED CIRCUIT BREAKER

- .1 In accordance with Section 26 28 16, Moulded Case Circuit Breakers, with rating as indicated on the drawings.

2.03 PANELBOARD

- .1 In accordance with Section 26 24 16, Branch Circuit Panelboards, with capacity and branch circuit details as per the drawings.

2.04 METERING CABINET

- .1 Utility approved wall mounting enamelled steel metering cabinet with backboard.

2.05 GROUND FAULT EQUIPMENT

- .1 In accordance with Section 26 28 20, Ground Fault Circuit Interrupters-Class A.

2.06 METERING CURRENT AND POTENTIAL TRANSFORMERS

- .1 Supplied with metering equipment **by** the Utility

2.07 SERVICE ENTRANCE BOARD

- .1 Metal enclosed, factory assembled, dead front service entrance board assembly in accordance with the drawing plan, elevations, schedule, and any details, and in accordance with CAN/CSA-C22.2 No. 31 and all other applicable Codes and Standards.
- .2 **Enclosure:** Tamper-resistant enclosure consisting of individual sections cubicles constructed of cold rolled steel and bolted together and reinforced as necessary to form a self-contained structure with the necessary louvres for proper ventilation. The enclosure is to be NEMA/EEMAC Type 1 if the room is not sprinkler protected, NEMA/EEMAC Type 2 if the room is sprinkler protected, and finished with ANSI #61 grey enamel. The enclosure is to be complete with:
 - .1 **hinged access panels** where required, of formed sheet steel and equipped with gasketing, concealed steel hinges with stainless steel hinge pins, and a captive knurled thumb screws
 - .2 **metering cubicle**, for Utility metering equipment, full height and barriered to isolate the cubicle from adjoining cubicles
 - .3 **Utility metering CT's and PT's** as specified above in this Section
 - .4 **fused disconnect switch** as specified above in this Section
 - .5 **enclosed circuit breaker** as specified above in this Section
 - .6 **panelboard** as specified above in this Section
 - .7 **ground fault equipment** as specified above in this Section
 - .8 **power bus** from the load terminal of the main breaker or disconnect switch via the metering cubicle to main lugs of the distribution panelboard, consisting of rectangular, square edge, hard temper, high electrical conductivity copper with colour coded phasing
 - .9 **cable** with colour coded phasing from the load terminal of the main breaker or disconnect switch via the metering cubicle to lugs of the distribution panelboard
 - .10 **ground bus**, electrical grade copper extending the full width of the assembly at the bottom, with lugs at each end for attachment of ground conductors
- .3 **Acceptable Manufacturers:** Acceptable manufacturers are:
 - .1 Schneider Electric Canada

- .2 Eaton Electric Canada
- .3 Siemens Canada
- .4 Approved Equivalent

3 EXECUTION

3.01 INSTALLATION OF SERVICE ENTRANCE EQUIPMENT

- .1 Provide electric service entrance equipment where shown.
- .2 Wall mount the equipment where indicated but confirm exact location prior to installation.
- .3 Secure the service entrance board in place, level, and plumb, on a concrete housekeeping pad.
- .4 Make "line" and "load" side connections as indicated.
- .5 Check protective devices against the coordination study results to ensure proper operation of the devices.
- .6 Ground and bond as indicated and as per the electrical work Section entitled Grounding- Secondary.
- .7 If service entrance equipment identification is not factory installed, install at the site using stainless steel screws.
- .8 Supply a complete set of identified fuses for the disconnect switch and store in an identified wall mounted steel cabinet adjacent to the service entrance equipment.
- .9 **Equipment and System Manufacturer's Certification:** Refer to the article entitled Equipment and System Manufacturer's Certification in the Electrical Work General Instructions Section.
- .10 **Start-Up:** Refer to the article entitled Equipment and System Start-up in the Electrical Work General Instructions Section.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for all products specified in this Section.
- .2 **Panelboard Door Keys:** Submit an identified key (minimum 3) for panelboards equipped with doors.

1.02 QUALITY ASSURANCE

- .1 Distribution panelboards are to be rated to interrupt and withstand short circuit faults greater than the available fault current. Indicate conformance with this requirement on product data sheets submitted for review.

2 PRODUCTS

2.01 DISTRIBUTION PANELBOARDS

- .1 **General Re: Panelboards:** Distribution panelboards are to be dead front, factory assembled panelboards designed for sequence phase connection of branch circuit devices, as per the drawing schedule and plans, and in accordance with requirements of CAN/CSA- C22.2 No. 29, Panelboards and Enclosed Panelboards Industrial Products. Comply with OESC Rule 14-014 with regards to series rated combinations of over-current protective devices and ensure that equipment in which the lower rated devices are installed are marked with a series combination interrupting rating at least equal to the available fault current. Each panelboard is to be complete with:
 - .1 silver plated, electrical grade, 95% conductivity copper bus mains for the full length of each enclosure
 - .2 main and branch circuit conductor solderless lugs approved for copper conductors
 - .3 neutral bus and main lugs at the same end, and a removable cover for main lugs
 - .4 for panelboards in Elevator and/or Escalator Machine Rooms, hardware to permit padlocking the switch or breaker in the open position
- .2 **Panelboard Enclosures:** Panelboard enclosures, unless otherwise specified, are to be EEMAC 2 sprinkler-proof, constructed of Code gauge galvanized sheet steel, equipped with drip shields, and factory cleaned, primed, and finished with ASA-61 light gray equipment enamel. Each enclosure is also to be equipped with:
 - .1 wiring gutter space on all sides in accordance with CAN/CSA-C22.2 No.29 requirements
 - .2 space for future breakers/switches as applicable and as per the drawing schedule, and where spare beaker space is scheduled, breaker connector kits

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- .3 for panelboards in areas other than secure Electrical, etc., Rooms, a concealed hinged door and flush latch with keyed alike lock
 - .4 for free-standing floor mounted panelboards, reinforcement as required for a rigid enclosure
 - .3 **Circuit Breaker Panelboards:** Breakers are to be moulded case, bolt-on breakers in accordance with CSA-C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures, calibrated for operation in a 40° C (150° F) ambient temperature, sized in accordance with the drawing schedules, and complete with:
 - .1 a top main breaker
 - .2 for breakers 225 amperes and larger, a solid-state adjustable trip unit with long time, short time, and instantaneous time functions and time delays, set at ratings in accordance with the distribution coordination study
 - .4 **Switch and Fuse Panelboards:** Fusible switches are to be quick-make, quick-break, visible contact bolt-on switches in accordance with CSA-C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures, sized in accordance with the drawing schedules, and complete with:
 - .1 a top main switch
 - .2 operating handles which protrude through the dead front enclosure, interlocked with the switch mechanism, and equipped with facilities for padlocking in either the "ON" or "OFF" position
 - .3 fuse clips, and HRC fuses as per the drawing schedule
 - .5 **Modifications & Accessories:** Panelboards are to be factory equipped with modifications and accessories as follows:
 - .1 200% rated neutral
 - .2 insulated ground bus assembly
 - .3 isolated ground bus assembly
 - .4 sub-feed lugs
 - .5 through-feed lugs
 - .6 entry plates for Corflex cable
 - .7 a barriered main breaker or switch
 - .8 a main breaker/switch through the cover key interlock
 - .9 an electrically held contactor in the mains, installed in a separate compartment with removable cover
 - .10 a shunt trip for the main breaker

- .11 undervoltage release for the main breaker
 - .12 an alarm switch for the main breaker
 - .13 a surge protection package with audible alarm and silence button, From "C" relay contact, and EMI/RFI filtering providing 50 dB noise attenuation at 100 kHz
- .6 **Acceptable Manufacturers:** Acceptable manufacturers are:
- .1 Eaton Canada
 - .2 Schneider Electric Canada
 - .3 Siemens Electric Canada
 - .4 Approved Equivalent

3 EXECUTION

3.01 INSTALLATION OF DISTRIBUTION PANELBOARDS

- .1 Provide distribution panelboards where shown. Ensure adequate operation and maintenance clearance on all sides of each panelboard as per Code requirements.
- .2 Wall mount panelboards independent of connected conduit.
- .3 Secure each free-standing panelboard, level and plumb, to a concrete housekeeping pad.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.
- .5 Identify each panelboard and each panelboard component with an engraved Lamacoid nameplate in accordance with requirements of the Section entitled Basic Electrical Materials and Methods. Confirm nameplate wording with the Consultant prior to manufacture. Include a printed circuit directory card in a frame with acetate cover.

END OF THE SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for products specified in this Section.
- .2 **Panelboard Door Keys:** Submit identified keys (minimum 6) for panelboard doors.

2 PRODUCTS

2.01 BRANCH CIRCUIT PANELBOARDS

- .1 **General Re: Panelboards:** Breaker type branch circuit panelboards are to be dead front, factory assembled panelboards designed for sequence phase connection of branch circuit breakers, as per the drawing schedule and plans, and in accordance with requirements CAN/CSA-C22.2 No. 29, Panelboards and Enclosed Panelboards Industrial Products. Comply with OESC Rule 14-014 with regards to series rated combinations of over-current protective devices and ensure that equipment in which the lower rated devices are installed are marked with a series combination interrupting rating at least equal to the available fault current.
- .2 Each panelboard is to be complete with:
 - .1 electrical grade, 95% conductivity copper sequence phase bus mains for the full length of each enclosure
 - .2 a fully capacity neutral unless otherwise specified
 - .3 main and branch circuit conductor solderless set-screw type lugs approved for copper conductors
 - .4 neutral bus and main lugs at the same end, and a removable cover for main lugs
 - .5 a manufacturer's nameplate which indicates panelboard characteristics including the fault current that the panelboard, including breakers, has been constructed to withstand
- .3 **Panelboard Enclosures:** Panelboard enclosures, unless otherwise specified, are to be EEMAC 2 sprinkler-proof, flush or surface mounted as indicated, constructed of Code gauge galvanized sheet steel, equipped with drip shields, and factory cleaned, primed, and finished with ASA-61 light gray equipment enamel. Each enclosure is also to be equipped with:
 - .1 wiring gutter space on all sides in accordance with CAN/CSA-C22.2 No. 29 requirements
 - .2 space for future breakers as applicable and as per the drawing schedule
 - .3 a concealed hinged door and flush latch with keyed alike lock, and a frame with acetate cover and a circuit directory card on the inside face of the panel door
 - .4 mylar circuit breaker identification strips secured in place

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- .4 **Circuit Breakers:** Breakers are to be moulded case, bolt-on breakers in accordance with CSA/C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures, calibrated for operation in a 40° C (105° F) ambient temperature, sized in accordance with the drawing schedules, and as follows:
- .1 branch circuit breaker interrupting capacity is to suit the panelboard voltage and be as scheduled, or in accordance with Code requirements to suit the application
 - .2 odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number
 - .3 for ground fault breakers, CSA Class A, Group 1 combination thermal magnetic trip breakers with solid-state ground default interrupters
 - .4 for breakers 225 amperes and larger, a solid-state adjustable trip unit with long time, short-time, and instantaneous time functions and time delays, set a ratings in accordance with the distribution coordination study
 - .5 for dedicated breakers, handle lock devices
 - .6 as scheduled or shown, spare breakers or space for future breakers
- .5 **Modification & Accessories:** Where indicated on the drawings or scheduled, panelboards are to be factory equipped with modifications and accessories as follows:
- .1 A factory installed, maintenance free surge protective device (SPD) in accordance with ANSI/UL 1449, connected to bussing through a disconnected device and equipped with a diagnostic package with status indicators on each phase, LCD six- digit surge counter display, EMI/RFI filtering, audible alarm with silence button, and Form C alarm contacts
 - .2 200% neutrals for panelboards equipped with SPD units and other panels as scheduled
 - .3 insulated ground bus assembly
 - .4 sub-feed lugs
 - .5 through-feed lugs
 - .6 a non-automatic or automatic (as schedule) main breaker
- .6 **Power Xpert Branch Circuit Monitor:** Where indicated on the drawings or schedules, supply CSA listed microprocessor-based Branch Circuit Monitoring System (Eaton PXBCM), or approved equal having the specified features.
- .1 System shall consist of meter base and meter modules as described below;
 - .2 The Branch Circuit Monitor shall measure the following operational data for up to 84 branch load circuits:
 - .1 Forward and Reverse kWh
 - .2 Watts, VA, Amps, Power Factor

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- .3 Present and Peak demand readings for Amps, Forward and Reverse Watts
 - 4 Maximum Watts, VA, Amps
 - .3 The Branch Circuit Monitor shall support alarms for current that can be set based on percent of Breaker Rating and alarms for voltage based on percent of nominal voltage.
 - .1 High, High-High, Low, Low-Low non-latching alarms for current.
 - .2 High and Low latching alarms for current, resettable via Modbus or the WEB interface
 - .3 High and Low latching and non-latching voltage alarms for each meter module input voltage.
 - .4 Alarm Status and alarm counters shall be available via Modbus communications
 - .4 Branch Circuit monitor shall support upgradeable firmware via communications.
 - .5 The Branch Circuit Monitor shall have the following ratings
 - .1 Elevation: 0 – 9843 ft (0 – 3000M)
 - .2 Pollution degree: 2 (IEC 60644-1)
 - .3 Ambient temperature range: -20°C – +70°C (-4° – +158°F)
 - .4 Storage temperature range: -40°C to +85°C (-40°F - +185°F)
 - .5 Humidity: 5% – 95% non-condensing.
 - .6 PXBCM as a component shall have a NEMA 1 rating. When installed in an enclosure it shall have the same rating as its enclosure.
 - .7 Housing ingress protection: IP20 as a component, in an enclosure the same as the enclosure
 - .8 CE Mark
 - .9 EMC (Electromagnetic Compatibility)
 - .1 IEC61326: EMI IEC61000-4-X level 3
 - .2 CISPR 11: Class B emissions, CISPR 22 (Ethernet) class B emissions
 - .3 FCC part 15 Class B emissions
 - .4 UL/cUL 61010-1 3rd edition
 - .5 EN61010-1

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- .6 PXBCM Meter Base or approved equivalent.
- .1 Each PXBCM-MB Meter Base or approved equivalent shall support connection of up to 4 Meter Modules in either a MMS Strip or MME External configuration monitoring a total of up to 100 single-phase two-wire AC loads, 48 single-phase three-wire AC loads or 32 three-phase four-wire AC loads or combinations not to exceed 25 poles per meter module.
 - .2 The PXBCM-MB or approved equivalent shall be equipped with 4 meter module ports. Each port shall provide control power and communications to either a PXBCM-MMS Meter Module Strip or a PXBCM-MME Meter Module External with a maximum cable length of 28ft between each Meter Base and each Meter Module.
 - .3 Each PXBCM-MB or approved equivalent shall support connection to up to 4 PXBCM-MMS Meter Module Strip or 4 PXBCM-MME Meter Module External, or a combination of up to 4 total PXBCM-MMS and PXBCM-MME each meter module with independent single or three phase voltage metering circuits with inputs up to 277V L-N and 480V L-L.
 - .4 PXBCM-MB or approved equivalent Power Supply shall be rated for 100-277VAC L:N +/-10% CAT III, 47-63 Hz , 6W
 - .5 The PXBCM-MB or approved equivalent shall include a 3 terminal RS-485 serial port for Modbus RTU communications and an RJ-45 port for Ethernet communications. The Ethernet port shall support Modbus TCP communications as well as an Embedded WEB server.
 - .6 The PXBCM-MB or approved equivalent embedded WEB server shall support device configuration for to up to 4 PXBCM-MMS Meter Module Strip or 4 PXBCM-MME Meter Module External, or a combination of up to 4 total PXBCM-MMS and PXBCM-MME and display of up to 100 points of metering data. It shall be possible to save device configuration information to a file for archiving and for uploading to PXBCM.
 - .7 The PXBCM-MB or approved equivalent shall support connection to a pre-configured HMI via RS-485 serial port. The HMI shall not require configuration
 - .8 The PXBCM-MB or approved equivalent shall be equipped with LED's to indicate communications activity and Device/Alarm Status. An LED shall also indicate if Ethernet is configured for DHCP (automatically assigned IP address) or Fixed IP (manually assigned IP address). The PXBCM-MB shall be equipped with 2 rotary switches to assign Modbus Slave ID 1-99.
 - .9 The PXBCM-MB or approved equivalent shall be equipped with security mode switches to enable the device to operate in a secure mode to prevent tampering with device configuration and resets over comms.
 - .10 The PXBCM Meter Base or approved equivalent shall automatically sense the type of PXBCM Meter Module connected to each of its 4 meter module ports.
 - .11 The Configuration wizard shall support naming and configuration of up 100 virtual meters by assigning 1-3 channels of current to 1, 2 or 3 pole meters. Virtual meters shall

aggregate the channel data assigned to each virtual meter and report the aggregated virtual meter values for:

- .1 Forward and Reverse Energy
 - .2 Watts, VA, Average Amps and Power Factor
 - .3 Average and Peak demand for Watts and VA
- .7 PXBCM-MMS Meter Module Strip or approved equivalent
- .1 PXBCM-MMS Meter Module Strips shall be available in configurations to mount on either the left or right of a panelboard and contain 9, 15, or 21 CTs. Four additional 333mV connections shall be provided on each PXBCM-MMS for Auxiliary 333mV CT connections which can be used to monitor the panel mains or branch circuits. The MMS shall include both load current and voltage metering circuits providing meter data to the Meter Base.
 - .2 The PXBCM Meter Module Strip shall be available with either 9 CT's, 15 CT's or 21 CT's per assembly for factory assembly into Panelboards with 18, 30 or 42 poles. PXBCM MMS CT's shall have be rated for up to 100A continuous current monitoring and designed to mount in an Eaton PRL-1a, or PRL-2a Panelboard with 1 inch breaker pole spacing.
 - .3 PXBCM Meter Module Strip 1 inch center CTs shall have a window opening sufficient for insulated Aluminum conductor rated for 100A capacity
 - .4 The PXBCM Meter Module Strip shall support direct connection of one set of 3 phase nominal metering voltage inputs up to 277V L-N and 480V L-L voltages and shall be rated as Cat III.
 - .5 The Meter Modules can also monitor voltage in the following configurations:
 - .1 Three Phase, four wire wye
 - .2 Three phase, three wire delta
 - .3 Three phase, center tapped delta
 - .4 Three phase, three wire
 - .5 Single phase, two wire
 - .6 Power and Energy metering shall be performed based on the voltage assignment for each 100A strip mounted CT and 333mV Aux CT current input as configured using the embedded WEB server.
 - .7 PXBCM MMS Accuracy of kWh metering on branch circuits shall be rated for ANSI C12.20 0.5 accuracy class as a system, including 100A rated strip mounted solid core current transformers. kWh accuracy for 333mV input auxiliary circuits shall satisfy ANSI C12.20 0.5 class excluding external 333mV sensor performance.
 - .8 The PXBCM MMS shall be UL approved for mounting to the panelboard interior with no interference. Strip placement shall line up 1 inch center CT's with breaker poles and not impede the normal routing of branch circuit conductors in the panel enclosure.

- .1 The PXBCM MMS shall connect to the PXBCM MB using factory supplied cables.
- .2 PXBCM-MME Meter Module External
- .3 The PXBCM-MME provides the same metering functionality as the PXBCM- MMS but is used for retrofit or non-uniform/high-mix load applications where the PXBCM-MMS strip mounted 100A CT's cannot be applied.
- .4 The PXBCM Meter Module external shall support 25 channels of current using external 333mV current sensors connected to terminal strips on the PXBCM- MME.
- .5 The PXBCM Meter Module External shall support direct connection of one set of 3 phase nominal metering voltage inputs up to 277V L-N and 480V L-L voltages and shall be rated as Cat III.
- .6 The Meter Modules can also monitor voltage in the following configurations:
 - .1 Three Phase, four wire wye
 - .2 Three phase, three wire delta
 - .3 Three phase, center tapped delta
 - .4 Three phase, three wire
 - .5 Single phase, two wire
- .7 Power and Energy metering shall be performed based on the voltage assignment for each 333mV current sensor input as configured using the embedded WEB server.
- .8 PXBCM MMS Accuracy of kWh metering on 333mV input circuits shall satisfy ANSI C12.20 0.5 class excluding external 333mV sensor performance.
- .9 Optional HMI Display shall display data for all configured sub-meters.
 - .1 HMI configuration shall not be required for each sub-meter. The HMI shall discover the configuration information automatically.
 - .2 Displayed information shall include;
 - .1 Sub-meter name, current, voltage, energy consumption, demand, and power factor for up to 100 load circuits. Aggregated Power and Energy readings for any 1, 2 or 3 pole meters.
- .7 **Acceptable Manufacturers:** Acceptable Manufacturers are:
 - .1 Eaton Canada

-
- .2 Schneider Electric Canada
 - .3 Siemens Electric Canada
 - .4 Approved Equivalent

3 EXECUTION

3.01 INSTALLATION OF BRANCH CIRCUIT PANELBOARDS

- .1 Provide breaker type branch circuit panelboards where shown. Ensure adequate operation and maintenance clearance on all sides of each panelboard as per Code requirements.
- .2 Unless otherwise specified, supply panelboards from a single manufacturer only.
- .3 Wall mount panelboards independent of connected conduit. Accurately install with reference to wall finish and confirm exact locations prior to roughing-in.
- .4 Where two or more panelboards are installed in one enclosure equip the panelboards with double lugs and increase gutter capacity to accommodate additional cabling.
- .5 In addition to load circuit breakers scheduled and indicated for each normal power panelboard, provide five 15A-1P additional breakers for small power and miscellaneous mechanical loads, each connected with 30 m (100') of 12 mm (½") diameter EMT and two # 12 AWG plus ground, with terminations as directed during construction.
- .6 Provide additional devices and accessories for panelboards as indicated and/or scheduled.
- .7 For each GFI breaker demonstrate in the presence of the Consultant that the protected circuit will trip when a simulated ground fault is applied to the "load" side of the breaker, and meggar the "load" side neutral to ensure that the neutral is not grounded on the "load" side of the GFI.

End of Section

1 GENERAL

1.01 SUBMITTALS

- .1 **Shop Drawings/Product Data:** Submit shop drawings and product data sheets for all equipment specified in this Section.
- .2 **Test Reports:** Submit signed test reports for all testing work specified in Part 3 of this Section.
- .3 **Manufacturer's Installation Certification Letter:** Submit an installation certification letter from the equipment manufacturer as specified in Part 3 of this Section.

1.02 QUALITY ASSURANCE

- .1 **Codes and Standards:** Each ground fault unit is to be in accordance with requirements of the following Codes and Standards:
 - .1 CAN/CSA C22.2 No.144, Ground Fault Circuit Interrupters
 - .2 NEMA PG 2.2, Application Guide to Ground Fault Protection Devices for Equipment
- .2 **Training and Instructions:** As specified in Part 3 of this Section.

2 PRODUCTS

2.01 GROUND FAULT PROTECTION EQUIPMENT

- .1 Panel mounting (unless otherwise indicated) ground fault protection units(s) supplied by one manufacturer, designed to operate instantaneously at the ground current setting, and with characteristics as indicated on the drawings. Each unit is to be complete with:
 - .1 a ground fault sensing relay for operation at the setting indicated on the drawings, and with 120 volt control voltage
 - .2 an ammeter with a 0 to 5 ampere scale to indicate the ground fault current
 - .3 a 3 position sensitivity control switch to select the value of leakage current at which the relay will operate

an identified indicating LED which is illuminated when no ground fault exists and is extinguished when a ground fault occurs or the unit is tested

- .5 a manual reset switch with manual target indication and SPDT contacts for alarm and trip, and a reset button for the contacts and target
- .6 a zero sequence transformer of a type to suit the conductors involved, with 300 to 3000 mA range
- .7 an artificial neutral and grounding resistor or a neutral ground resistor unit to suit the system

2.02 ACCEPTABLE MANUFACTURERS: Acceptable manufacturers are:

- .1 Schneider Electric Canada
- .2 Eaton Canada
- .3 Siemens Canada
- .4 Approved Equivalent

3 EXECUTION

3.01 INSTALLATION OF GROUND FAULT PROTECTION EQUIPMENT

- .1 Provide ground fault protection equipment for electric service entrance and distribution equipment where shown.
- .2 Where ground fault equipment is to be part of an assembly such as switchgear, arrange for the ground fault equipment to be shipped to the distribution equipment manufacturer's plant for factory installation.
- .3 Ensure that the neutral on the load side of the sensor is not grounded, and that phase conductors including the neutral are installed through the zero sequence transformer.
- .4 Make all required conductor connections with proper terminations in accordance with the ground fault unit manufacturer's instructions and requirements.
- .5 When installation is complete but before the system is energized, arrange for the manufacturer's authorized service representative to visit the site to inspect the installation, check trip settings, test operation of the units including simulated ground faults, and, when the inspections and reports have been satisfactorily completed, checked, and the equipment operates as intended, submit a copy of an inspection certification letter to the Consultant.

3.02 TRAINING AND INSTRUCTION

- .1 Ground fault protection equipment operation and maintenance training is to be done by qualified manufacturer's personnel in accordance with requirements specified in the electrical work section entitled Electrical Work General Requirements, and is to consist of a minimum of 2 on-site 4 hour sessions for 6 people per session.

END OF SECTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The Contractor shall provide and install the Diesel Generator onsite as per the manufacturer's instructions. The installation shall come with all safeties and the devices required for the successful operation of the Generator.
- B. Startup and commissioning of the Generator shall be done by the representative from the Generator Manufacturer.

1.3 DEFINITIONS

- A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the engine manufacturer.
- B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Thermal damage curve for generator.
 - 2. Time-current characteristic curves for generator protective device.
 - 3. Sound test data, based on a free field requirement.
 - 4. Prototype Testing Report
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.
 - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - 2. Wiring Diagrams: Control interconnection, Customer connections.

C. Certifications:

1. Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for EPA, stationary emergency application.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

1. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.
2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
3. List of factory tests to be performed on units to be shipped for this project.
4. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.

B. Warranty:

1. Submit manufacturer's warranty statement to be provided for this project.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100km of project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer. The supplier must be a reputable manufacturer with a minimum of 50-years of experience in building, designing, and manufacturing generators. The generator manufacturer shall be the original equipment manufacturer (OEM) for the diesel engine, alternator, and all the generator mounted controls.
- D. Comply with the follow local and national code requirements:
1. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
 2. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).
 3. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.
 4. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
 5. CSA 282-19 Emergency Electrical Power Supply for Buildings

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6. CSA, B139-19 – Installation Code for Oil-Burning Equipment
 7. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.
 8. ULC S601-14 – Standard for Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids
 - a. ULC S661-10 – Standard for Overfill Protection Devices For Flammable and Combustible Liquid Storage Tanks
 9. ULC S675.2-14 – Standard for Nonvolumetric Precision Leak Detection Devices for Underground and Aboveground Storage Tanks and Piping For Flammable and Combustible Liquids
 10. ULC-S663-11(R2016) – Standard for Spill Containment Devices for Flammable and Combustible Liquid Above Ground Storage Tanks
 11. UL1236 – Battery Chargers
 12. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed. The generator set and all accessories shall be CSA certified.
 13. ANSI S1.13-1971—Measurement of Sound Pressure Levels in Air
- E. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - F. Noise Emission: Comply with Ministry of Environment for maximum noise level at 75dBA@7m due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
 - G. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: -30.0 deg C (-22.0 deg F) to 50.0 deg C (122.0 deg F)
 2. Relative Humidity: 0% to 95%
 3. Altitude: Sea level to 1640.42 feet (500.0m)

1.8 WARRANTY

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- A. . Base Warranty: Manufacturer shall provide base warranty coverage on the material and workmanship of the generator set for a minimum of twenty-four (24) months from completion of generator commissioning. Warranty coverage will be comprehensive and cover all parts, labour and travel. The owner is not to incur any expenses for approved warranty repairs during the 24-month period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Manufacturers: The equipment shall be produced by a manufacturer who is ISO 9001 certified for design, development, The power system shall be produced by a manufacturer who has produced this type of equipment for a period of at least 10 years and who maintains a service organization available twenty-four hours a day throughout the year.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
- C. Capacities and Characteristics:
1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 175kW, at 80 percent lagging power factor, 347/600, Series Wye, Three phase, 3 -wire, 60 hertz.
 2. Alternator shall be capable of accepting a motors starting load of 516.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.
- D. Generator-Set Performance:
1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
 2. Transient Voltage Performance: Not more than 33% variation for 100% step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 5 seconds.
 3. Steady-State Frequency Operational Bandwidth: 0.25% of rated frequency from no load to full load.

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4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 5. Transient Frequency Performance: Not more than 20% variation for 100 % step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds.
 6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
 7. Sustained Short-Circuit Current: Generator sets must use a PMG-excited alternator. For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components.
 8. Start Time: Comply with CSA 282, 15-second requirement.
 9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

2.3 ENGINE

- A. Fuel: ASTM D975 #2 Diesel Fuel
- B. Rated Engine Speed: 1800RPM.
- C. Lubrication System: The following items are mounted on engine or skid:
 1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
 2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
 3. Crankcase Drain: Arranged for complete gravity drainage with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions.
- E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system.

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1. Designed for operation on a single 240 VAC, 3-phase, 60Hz power connection. Heater voltage shall be selected by the generator manufacturer for proper operation based on the engine size.
 2. Provided with a thermostat, installed at the engine thermostat housing
- G. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
- H. Cooling System: Closed loop, liquid cooled
1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 50 deg C.
 2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- I. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.
- J. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
- K. Starting System: **12V**, as recommended by the engine manufacturer; electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 2. Cranking Cycle: As required by CSA C282.
 3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
 4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.

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5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
 6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger rated at a minimum of 10A. It will include the following features:
 - a. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of AC input or DC output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel. These outputs are to be wired to the building's SCADA by the site's contractors if required for the project's scope.
 - e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
 - f. Enclosure and Mounting: NEMA, Type 1, wall-mounted enclosure.

2.4 FUEL OIL STORAGE

- A. Comply with CSA B139-19 code requirements.
- B. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be UL 142 and ULC S601 listed and labeled. The fuel tank shall include the following features:
 1. Capacity: Minimum of 2,793 Liters of usable fuel for 48-hours of operation at 100% load.
 2. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.
 3. Electrical stub up(s)
 4. Normal & emergency vents
 5. Mechanical fuel level gauge

6. Low-level Switch

- a. Low level switch is to be wired to the generator's controller to provide a warning alarm if the fuel tank level is below 40%.

7. High Fuel Alarm Panel

- a. Fuel alarm panel is to be ULC approved per the code requirements in Section 1.6.
- b. High-level float switch is to be provided and wired to the panel to indicate the fuel level has reached 90% of the fuel tank capacity during filling.

8. Leak detector switch

- a. Leak detector switch is to be wired to the generator's controller to provide a warning alarm if the fuel tank level is below 40%.

9. Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.

10. 3.5-gallon (13.24L) spill container with lockable/tamper proof fuel fill access.

- a. Spill container is to be ULC approved per the code requirements in Section 1.6.
- b. Container must be made of 16 gauge spun steel and power coated to prevent rusting.

11. Tank design shall meet CSA B139 (latest edition) and the regional requirements for the project location.

2.5 CONTROL AND MONITORING

- A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
- B. Automatic Starting System Sequence of Operation: When mode-selector button on the control panel is pressed for "Auto", remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. The "STOP" button initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- C. Manual Starting System Sequence of Operation: Selecting the "Manual" then "Start" button on the generator control panel starts generator set. The "STOP" button initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall

isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

E. Indicating and Protective Devices and Controls:

1. AC voltage (3-phase, line to line and line to neutral values).
2. AC amperage (3-phases).
3. AC frequency
4. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
5. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
6. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
7. DC voltage (alternator battery charging).
8. Engine-coolant temperature gauge.
9. Engine lubricating-oil pressure gauge.
10. Engine hour-meter.
11. Fuel tank alarms:
 - a. Low fuel level
 - b. Leak detection/Rupture basin
12. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR over current, loss of voltage reference, and over excitation shut down protection. There shall be a overload warning, and overcurrent warning alarm.
13. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
14. A display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
15. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.

16. Data Logging: The control system shall log the latest 32 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
17. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

2.6 REMOTE CLOUD MONITORING

- A. Provide a cloud based remote monitoring system/module with the supply of the generator.
 1. The system shall provide means of remote monitoring generator sets and transfer switches via a website and an APPLE IOS/ANDROID phone app.
 - a. The device shall support monitoring a minimum of 2 and up to a maximum of 5 individual devices per customer location.
 - b. Access to the cloud-based website or app shall be free of charge to the end user. There shall be no fees, set-up charges or monthly subscriptions associated with this service.
 2. The hardware shall be 4G LTE cellular (with 2G or 3G fallback), LAN and Wi-Fi (WPA2/PSK/CCMP, 2.4GHZ, AES-128 encryption) capable.
 - a. Dynamic Host Configuration Protocol (DHCP) capability is required.
 - b. Communication from the device to the generator and ATS shall be over Modbus RS-485. Shielded twisted pair cable, Belden 9729 or equivalent wiring must be compatible with the device.
 - c. Any additional protocol conversion modules that may be required to communicate between the cloud monitoring device and the generator/transfer switch shall be included.
 - d. Power requirements for the device must be 9 – 32VDC and is to be provided via B+ connections from the generator's batteries.
 - e. Firmware updates by the manufacturer must be available via Firmware over the Air (FOTA) protocol. Firmware is to be pushed via the cloud network and updates are to be installed either during the next power cycle or automatically after two weeks.
 - f. Device shall have five configurable digital inputs and four configurable analog inputs available for monitoring customer equipment or additional generator and transfer switch information.
 3. The cloud-based website or APP shall provide the following functionalities for the end user:
 - a. A single account that has a list and a live location map on the home page of the different individual locations/sites where the monitored equipments are installed.

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- i. The status (warning, fault/shutdown, online/offline) of each generator or transfer switch shall be easily identifiable on the equipment list or map without the need to click on each individual equipment and navigating to another page.
 - b. The customer's accounts shall have the following user role capabilities and permissions:
 - i. Account Owner –View, add, edit, and delete access for various account and site permissions.
 - ii. Account Manager – View, add, edit, and delete access for various account permissions (except Account Owner) and site permissions.
 - iii. Service Operator – View only access for account permissions. View, add, edit, and delete access for site permissions.
 - iv. Read Access – View only access for account and site permissions.
 - c. A list of active and past/acknowledged events per device that records warning, shutdowns, and information per generator or transfer switch. Acknowledged events shall be available for a minimum of 30-days. Active events shall display and store a minimum of 100 events. All data logs shall be exportable for reports and records purposes.
 - d. Readouts of the analog and digital inputs that are connected to the remote monitoring device.
 - e. The remote monitoring device's model number, software version and recent loss of communication event logs.
 - i. Additional capabilities include remotely restarting the gateway, manual software update installations, and password resets.
 - f. Individually listed generator or transfer switch with model and serial number information per equipment. Each individual equipment shall have its own product page with the following capabilities:
 - i. The capability to manually start/stop the generator and reset any faults at the generator controller.
 - ii. Live display of alternator data including but not limited to: Voltage (L-L & L-N), Current, Frequency, Total KVA, Total kW, Total kWh, and Total Power Factor
 - iii. Live display of engine data including but not limited to: Battery Voltage, Engine Speed, Coolant Temperature, Oil Temperature, Oil Pressure, Fuel Level (if configured), Fuel Rate and Engine Run Time.
 - iv. The capability to perform a transfer test to the generator and back to utility and reset any faults on the transfer switch controller.
 - v. Live display of the current connected source (Source 1 – Utility or Source 2 – Generator), and the status of each source's availability.

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- vi. Live display of Source 1 and Source 2 data including but not limited to: Voltage (L-L & L-N), Frequency, Current, Total Power Factor, Total KVA, and Total KVAR.
 - vii. Each equipment page shall have an annunciator data with displays of NFPA110 and NFPA110 Extended alarms and warning listed. Each alarm or warning shall have the ability for colour identification based on the severity of the alarm (green for normal events, amber for warning alarms and red for faults).
 - g. Data trending to graphically plot or create reports for generator and transfer switch parameters over a preset duration (past 1-hour, past 24-hours, 7-days or 30-days).
 - h. Exercise scheduler to start and stop the generator with no load. Schedule can be set for: one time, daily, weekly biweekly, and monthly. Start date and timer selection capabilities shall be available for this function.
 - i. Maintenance reminders that can be programmed based on date/time or engine run hours. This function shall have the capability to email selected users of the account with details of the maintenance requirement.

2.7 ALTERNATOR, BREAKER, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Temperature Rise: 105°C / Class F environment.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125% of rating, and heat during operation at 110 percent of rated capacity.
- F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- G. Enclosure: Drip-proof.
- H. Voltage Regulator: SCR type, Separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Subtransient Reactance: 10% maximum, based on the rating of the engine generator set.
- K. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall

shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown).

- L. A comprehensive monitoring and control system integral to the generator's control system that guards the electrical integrity of the alternator and power system by providing protection against a wide array of fault conditions in the generator set or in the load. It also provides single and three phase fault current regulation so that downstream protective devices have the maximum current available to quickly clear fault conditions without subjecting the alternator to potentially catastrophic failure conditions. Thermal damage curve (3-Phase short) or fixed timer (2 sec for 1-Phase short, 5 sec for 2-Phase short). The system is a time-based generator protection applicable to both line-to-line and line-to-neutral, that can detect an unbalanced fault condition and swiftly react appropriately. Balanced faults can also be detected by the system and appropriately acted upon.
- M. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current at 0.8pF of the generator set on a continuous basis. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided. The breaker shall be provided

based on the size and electronic trip requirements (thermal magnetic available for a 150kW) as shown in the single line diagram.

- N. The generator shall be provided with a second load bank circuit breaker used for load testing purposes only at 1.0PF. The breaker shall be provided with a **12V** shunt trip contact. This contact is to be wired to the site's transfer switch "Loss of Utility" output contact to automatically trip the load bank breaker in the case of a utility power loss during testing and to prevent a shutdown of the generator due to overload conditions.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Sound attenuated aluminum housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.
- B. Construction:
 - 1. Hinged Doors with padlocking provisions.
 - 2. Exhaust System:
 - a. Muffler to be located within the enclosure but in a separate compartment located behind the radiator discharge area.
 - b. Exhaust shall terminate within the enclosure housing with adequate grates above to allow for proper exhaust flow dispersion.

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3. Hardware: All hardware and hinges shall be stainless steel.
 4. Wind Rating: Wind rating shall be 150 mph
 5. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
 6. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
- C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 50 deg C.
1. Radiator discharge shall be vertical.
 2. Louvers shall be motorized on the air inlet.
- D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 75 dBA measured at any location 7 m from the engine generator in a free field environment.
- E. Site Provisions:
1. Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.
- F. Enclosure Electrical:
1. Provide circuit breakers within the enclosure to isolate or disconnect power to the various generator auxiliary equipment. Breaker quantity and size as recommended by the generator manufacturer's engineered calculations for the items below – including battery charger, coolant heater, oil heater and high fuel alarm panel.
 - a. Main power supply to be 50A, 120V/240V, single phase that is to be terminated at a designated terminal block within the AC electrical section of the generator controller.
 - b. DC light meeting CSA C282 requirements with its own battery back-up or wired to the generator batteries. DC light to have a switch for manual operation.
 - c. Space heater, rated at 240V, to adequately keep the enclosure at 10°C at all times.

2.9 VIBRATION ISOLATION DEVICES

- A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

2.10 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color will be provided.

2.11 SOURCE QUALITY CONTROL

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- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110.
- B. Project-Specific Equipment Tests: Before shipment, the generator shall have a factory certified test report completed and available for engineering review. Prior to shipment of the generator to site – a factory witness test of the generator set manufactured specifically for this project will be conducted. Perform tests at rated load and unity power factor. If a certified test report is not provided showing the alternator had been tested at 0.8pF then a reactive load bank test will be required. Include the following tests:
1. Test engine generator set manufactured for this project to demonstrate compatibility and functionality.
 2. Full load run for 4-hours.
 3. Transient load steps for voltage, frequency, and kW. Load steps are as follows:
 - a. 0% - 25% - 0%
 - b. 0% - 50% - 0%
 - c. 0% - 75% - 0%
 - d. 0% - 100% - 0%
 4. Simulated safety shutdowns.
- C. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel, meals, and overnight accommodation expenses will be the responsibility of the owner and consulting engineer. Generator supplier is responsible to provide two weeks' notice for testing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with CSA C282.
- B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

- D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- E. Equipment shall be initially started and operated by representatives of the generator manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.
- F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
- G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.
- H. All CSA B139 and TSSA approvals/variances required for filling of the fuel tank is to be arranged by the contractor.

3.2 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system.
- B. Tests shall include:
 - 1. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
 - 2. Installation acceptance tests to be conducted on site shall include a "cold start" test, a four hour full load (resistive) test, and safety shutdown testing. Provide a resistive load bank and make temporary connections for full load test.
- C. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service and observing proper operation of the system for at least 1-hour per CSA C282. Coordinate timing and obtain approval for start of test with site personnel.

3.3 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

End of Section

1 GENERAL

- .1 Contractor to provide and install the ATS.
- .2 Startup and commissioning of the ATS shall be done by the representative from the manufacturer.

1.02 REFERENCES

- .2 CSA International
 - .1 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).
 - .2 CSA C22.2 No.178.1-, Automatic Transfer Switches.
 - .3 CAN/CSA C60044-1-, Instrument Transformers.
- .3 National Electrical Manufacturers Association (NEMA)
 - .1 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.

1.03 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01330 - 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 drawings

2 PRODUCTS

2.01 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 preset 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.

2.02 MATERIALS

- .1 Instrument transformers: to CAN/CSA C60044-1.
- .2 Contactors: to NEMA ICS2.

2.03 CONTACTOR TYPE TRANSFER EQUIPMENT

- .1 Contact Type Transfer Equipment: to CSA C22.2 No.178.1.
- .2 Two - 4 pole contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, motor solenoid operated, open type with CSA enclosure.
- .3 Rated: 208 V, 60Hz, 400 A. 4 wire, solid neutral.
- .4 Main contacts: silver surfaced, protected by arc disruption means.
- .5 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.
- .6 Auxiliary contact: gold plated, to initiate emergency generator start-up on failure of normal power.
- .7 Fault withstand rating: 35 kA symmetrical for 3 cycles with maximum peak value of 35 kA.
- .8 Lever to operate switch manually when switch is isolated.
- .9 Neutral bar, solid rated: 400 A.
- .10 Overlapping neutral contacts on contactor type transfer equipment.

2.04 CIRCUIT BREAKER TYPE TRANSFER EQUIPMENT

- .1 Circuit Breaker Type Transfer Equipment: to CSA C22.2 No.5.
- .2 Rated: 208 V, 60Hz, 400 A, 4 wire, solid neutral.
 - .1 Fault withstand rating: 35 kA symmetrical for 3 cycles with maximum peak value of 35 kA.
 - .2 One normal - 3 pole moulded-case circuit breaker with thermal magnetic, mounted on common base, designed for double throw action, motor operated, mechanically held and interlocked.
 - .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: 35 A symmetrical.
 - .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 Solid neutral bar, rated: 400 A.
 - .8 Overlapping switchable neutral pole on circuit breaker type equipment.

2.05 CONTROLS

- .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: dry type with 120 V secondary to isolate control circuits from:
 - .1 Normal power supply.
 - .2 Emergency power supply.
- .3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:
 - .1 Voltage sensing: 3 phase for normal power and on one phase only for emergency, solid state type, adjustable drop out and pick up, close differential, 2 V minimum undervoltage and over voltage protection.
 - .2 Time delay: normal power to standby, adjustable solid state, 0 to 60 s to 180 s 20 s to 10 minutes.
 - .3 Time delay on engine starting to override momentary power outages or dips, adjustable solid state, 0 to 60 s 3 to 20 s delay.
 - .4 Time delay on retransfer from standby to normal power, adjustable 0 to 60 s 5 to 180 s 20 s to 10 minutes.
 - .5 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, 0 to 60 s 5 s intervals to 180 s 20 s intervals to 10 minutes.
 - .6 Time delay during transfer to stop transfer action in neutral position to prevent fast transfer, adjustable, 5 s intervals to 180 s.
 - .7 Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.
 - .8 Neutral disconnected position delay: allow time for motors to delay between live sources, adjustable, 0 to 5 s.
- .4 Solid state electronic in-phase monitor.

2.06 ACCESSORIES

- .1 Ensure pilot lights indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel.
- .2 Auxiliary relay to provide 2 N.O. and 2 N.C. contacts for remote alarms.
- .3 Manual bypass and isolator: to normal supply.

2.07 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 5 nameplates.
 - .2 For meters, indicating lights, minor controls: use size 3 nameplates.

2.08 SOURCE QUALITY CONTROL

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Consultant.
- .2 Notify Consultant 10 days minimum in advance of date of factory test.
- .3 Tests:
 - .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.

3 EXECUTION

3.02 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.
- .4 Connect to Solar Inverters to disable inverters when generator is running.

3.03 FIELD QUALITY CONTROL

- .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, 3 times, complete test with selector switch in each position, for each test.

End of Section

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for lighting fixtures. Include certified fixture photometric data which includes total input watts, candlepower summary, candela distribution zonal lumen summary, CIE type coefficient of utilization, and lamp type and lumen rating in accordance with CSA IESNA testing procedures.
- .2 **Lighting Fixture Colour(s):** For all lighting fixtures where the colour is to be selected after award of the Contract, submit colour charts and obtain fixture colour information in writing prior to ordering.
- .3 **Spare Lamps:** Submit spare lamps as specified in Part 3 of this Section.

1.02 QUALITY ASSURANCE

- .1 All lighting fixtures are to be ULC listed and/or CSA certified and labelled.

2 PRODUCTS

LED LIGHTING FIXTURES

2.01 FIXTURE CONSTRUCTION

- .1 Fixtures must be constructed of 20 gauge (minimum) cold rolled steel. All metal edges require smooth finish.
- .2 Light leaks must be prevented by providing gasketting, stops, and barriers.
- .3 Fixtures must be finished in high reflective baked white enamel. This surface must have a reflectance of not less than 85%.

2.02 FIXTURE LENS

Unless otherwise noted fixture lenses shall be as follows:

- .1 Lens thickness: 3.2mm (1/8")
- .2 Material: injection moulded clear prismatic virgin acrylic.
- .3 Frame: hinged, latched, steel.

2.03 LED FIXTURES

- .1 Fixture LED'S must be tested in conformance with IESNA LM80 standard.
- .2 LED's must be selected using a binning algorithm to ensure colour and lumen output of a given fixture are consistent, as well as meet or surpass ANSI C78.377 specification for the rated lifetime of the fixture. Colour accuracy between products must be within a 2 step MacAdam ellipse

- .3 Luminaires must be tested in conformance with IESNA LM79 by an independent approved laboratory.
- .4 Luminaires must be tested prior to shipping.
- .5 Luminaires must be ULC certified and approved for use in Canada.
- .6 Fixtures must maintain a minimum of 90% of their initial light output for 60,000 hours. Submit test result upon request.
- .7 Lumen values indicated for fixtures in the project documents are to be considered as “absolute” or “delivered” values.
- .8 Other than for specialty fixtures, and unless otherwise indicated, the maximum driver current is to be 750 mA.

3 EXECUTION

3.01 INSTALLATION OF LIGHTING FIXTURES

- .1 **General Installation Requirements:** Provide lighting fixtures and lamps where shown. Include for all required site assembly, and provide all required installation and support hardware. Additional requirements are as follows:
 - .1 confirm exact lighting fixture locations prior to roughing-in
 - .2 in finished areas, refer to architectural reflected ceiling plans and/or wall elevations
 - .3 in equipment rooms, shafts, and similar unfinished areas, install fixtures after the equipment is roughed-in, and shelving and similar items are installed, and do not suspend fixtures from piping, ductwork, conduit equipment, or similar items
 - .4 prior to roughing-in for lighting fixture installations, examine drawings and site conditions to determine that suitable space is available for the fixture installation as shown. If sufficient space is not available, notify the Consultant immediately and, if required, relocate the fixtures within reasonable distances without additional cost
 - .5 locate recessed downlights, troffers, and surface mounted fixtures in or on suspended tile ceilings in or on full tiles, and where ceiling tile openings are cut for fixtures, cut to exact sizes so that there are no gaps, and fixture trim completely covers the perimeter of the opening
 - .6 provide plaster frames for fixtures in suspended plaster or drywall ceilings
 - .7 use clean gloves when handling reflector cones, louvres, halogen lamps, glass sconces, and all exposed surfaces of fixtures.

3.02 SUSPENDED LIGHTING FIXTURES

- .1 Support all lighting fixtures in suspended ceilings from the slab or building construction above, independent of the suspended ceiling construction. Support 1.2 m (4') fluorescent fixtures with a minimum of 2 aircraft type cable supports or 2 #3 Tenso Chains. Support HID or incandescent fixtures with 1 #3 Tenso Chain or 1 aircraft type cable. All supports are to be in accordance with requirements of governing Codes and Regulations.
- .2 Support continuous rows of fixtures at minimum 1.2 m (48") centres.

3.03 LIGHTING FIXTURES IN FIRE RATED CEILING CONSTRUCTION

- .1 Where lighting fixtures penetrate a fire rated ceiling they are to be enclosed in an enclosure with a rating to match that of the ceiling. The enclosure is to be constructed by the trade constructing the ceiling. Ensure that conductors connecting the fixtures are fire rated type and that ceiling penetrations for conductors are properly sealed with fire stopping and smoke seal material. Fixtures installed in the fire rated enclosures are to be equipped with thermal overload protection.

3.04 LIGHTING FIXTURES ALIGNMENT

- .1 Align lighting fixtures mounted in continuous rows to form straight uninterrupted lines. Alignment variation is not to exceed 6 mm (¼") in any 5 m (15') run.
- .2 Align lighting fixtures mounted individually parallel and/or perpendicular to building lines.
- .3 Aim accent and spot lighting as indicated and/or as directed by the Consultant, and secure the fixture positions after the Consultant's approval.

3.05 LIGHTING FIXTURES CIRCUIT WIRING

- .1 Connect lighting fixtures to circuits indicated with wiring as shown/specified.
- .2 Minimize the number of splices required.

3.06 CLEANING

- .1 When all lighting fixture installation work is complete, clean all fixtures and lamps, and any ceiling, wall, etc., surfaces soiled as a result of the fixture installation work.
- .2 If wall and ceiling surfaces are damaged as a result of the fixture installation, replace the wall or ceiling surface to the Consultant's approval.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Product data submittal requirements are as follows:
 - .1 submit product data sheets for lighting fixtures, and include certified horizontal and vertical beam spread, beam lumens, beam efficiency, complete photometric data which includes total input watts, candlepower summary, candela distribution zonal lumen summary, CIE type, coefficient of utilization, and lamp type and lumen rating in accordance with CSA IESNA testing procedures.
 - .2 for floodlighting fixtures, computer printout for aiming angles.
 - .3 for pole mounted fixtures, submit documentation to confirm that the poles proposed are suitable for the steady wind velocity and wind gust velocity data for the area of installation, and for the total weight and project area of the fixtures.
 - .4 submit complete design and construction shop drawings for pole mounted fixture concrete bases, prepared, stamped and signed by a Professional Structural Engineer registered in the place of the work.
- .2 **Lighting Fixture and Accessory Colour(s):** For all lighting fixtures and accessories where the colour is to be selected after award of the Contract, submit colour charts and obtain fixture and accessory colour information in writing prior to ordering.
- .3 **Spare Lamps:** Submit spare lamps as specified in Part 3 of this Section.

1.02 QUALITY ASSURANCE

- .1 All lighting fixtures and lamps are to be ULC listed and/or CSA certified and labelled.

2 PRODUCTS

2.01 GENERAL RE: LIGHTING FIXTURES

- .1 Lighting fixtures and lamps are scheduled on the drawings.
- .2 All lighting fixtures are to be completely weatherproof, non-corrosive, suitable in all respects for the mounting locations indicated on the drawings and are to be complete with all required mounting hardware.
- .3 All lighting fixtures are LED lighting fixtures.
- .4 Confirm exact colour and finish of lighting fixtures at the submittals stage and prior to ordering.

2.02 POLES

- .1 **Concrete Poles:** Reinforced, pre-stressed, round, tapered, spun concrete pole, plain grey finish, designed for underground wiring and for direct bury, sized as indicated on the drawings, and complete with an access hand hole with frame and cover for wiring connections 450 mm (18") above

grade, and a suitably sized grounding lug.

- .2 **Steel Poles:** Hot dipped galvanized, minimum 4.5 mm ($\frac{1}{8}$ ") thick steel, round or octagonal monotube style poles sized as indicated on the drawings, designed for underground wiring and mounting on a concrete base. Unless otherwise specified poles are to be tapered and complete with an access hand hole with frame and cover for wiring connections 450 mm (18") above grade, a minimum of four non-corrosive anchor bolts and nuts with shims and tamper-proof covers, and a suitably sized grounding lug.
- .3 **Aluminium Poles:** G063-T6 aluminium, minimum 3 mm (3/16") thick, round or octagonal monotube style poles sized as indicated on the drawings, designed for underground wiring and mounting on a concrete base. Unless otherwise specified poles are to be tapered and complete with an access hand hole with frame and cover for wiring connections 450 mm (18") above grade, a minimum of four non-corrosive anchor bolts and nuts with shims and tamper-proof covers, and a suitably sized grounding lug.

2.03 LIGHTING FIXTURE MOUNTING BRACKETS

- .1 Corrosion-resistant metal brackets, cantilevered without under-braces, of sizes and styles specified with the fixtures they are required for, and complete with all required non- corrosive mounting and connection hardware.

3 EXECUTION

3.01 INSTALLATION OF EXTERIOR LIGHTING FIXTURES

- .1 Provide exterior lighting fixtures where shown and in accordance with the drawing schedule. Include for all required site assembly, and provide all required installation and support hardware.
- .2 Confirm exact lighting fixtures locations prior to roughing-in.
- .3 Secure grade mounted building floodlighting fixtures to concrete pads set flush with finished grade.

3.02 INSTALLATION OF LIGHTING FIXTURES POLES

- .1 Provide poles with mounting brackets for pole mounted lighting fixtures. For direct bury concrete poles, backfill the excavation around the pole with concrete.
- .2 Secure metal poles to reinforced concrete bases. Install pole anchor bolt support hardware in the base concrete during the pour, and ensure that the hardware is properly positioned and remains properly positioned until concrete has set. Provide vandal-proof anchor bolt covers.
- .3 Refer to pole concrete base detail indicated on the drawings.
- .4 Ensure that all poles are true and plumb.

3.03 CONCRETE, EXCAVATION AND BACKFILL WORK

- .1 Carefully coordinate concrete and excavation and backfill work with the trades performing the work.

-
- .2 Perform all required concrete and excavation and backfill work in accordance with requirements of Division 03 and Division 31.

3.04 LIGHTING FIXTURES ALIGNMENT

- .1 Aim and align building floodlighting and/or spotlighting during evening hours under the direction and to the approval of the Consultant, and secure the fixture positions after the Consultant's approval.

3.05 LIGHTING FIXTURES CIRCUIT WIRING

- .1 Connect lighting fixtures to circuits indicated with wiring as specified. Install wiring in conduit.
 - .2 Minimize the number of splices required.
- .3 Connect metal parts of poles with ground conductors connected to the building grounding system.

3.06 CLEANING

- .1 When all lighting fixtures installation work is complete, clean all fixtures and lamps, and surfaces soiled as a result of the fixture installation work.
- .2 If building surfaces are damaged as a result of the fixture installation, repair the surface to the Consultant's approval.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for emergency lighting. Include complete battery charger data, battery charger and discharge voltage/time characteristics, and, where required, certified wiring diagrams.
- .2 **Battery Warranty:** Submit a copy of the battery warranty specified below, and include a copy in the O & M Manual.
- .3 **Letter of Certification:** As per Part 3 of this Section, submit a letter from the representative of the emergency lighting manufacturer to certify that the installation has been tested and adjusted and operates as intended.

1.02 QUALITY ASSURANCE

- .1 All emergency lighting is to be CSA certified in accordance with:
 - .1 CSA C22.2 No. 141, Unit Equipment for Emergency Lighting
 - .2 UL 924, Standard for Emergency Lighting and Power Equipment
 - .3 CSA C22.2 No. 107.2, Battery Chargers

1.03 WARRANTY

- .1 For batteries, the Contract warranty is to be extended to ten years with no-charge replacement during the first five years, and a pro-rate charge during the last five years. Submit a signed copy of the warranty in the name of the Owner.

2 PRODUCTS

2.01 SELF-CONTAINED EMERGENCY LIGHTING UNITS

- .1 Lumacell Inc. Model RG24S720 solid-state, factory assembled and tested, 120 volt AC input, 12 volt or 24volt DC output, battery operated emergency lighting units, each capable of supplying the specified load for the length of time indicated, and to automatically shut-off. Each unit is to be complete with:
 - .1 a white enamelled steel cabinet suitable for shelf or direct wall mounting, with conduit knock-outs and a removable or hinged front panel for battery access
 - .2 white enamelled steel mounting and support hardware to suit installation locations indicated
 - .3 a sealed, maintenance-free battery in a high-impact, heat resistant translucent plastic casing
 - .4 a multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected pulse type battery charger with a regulated output of ± 0.01 volts

for $\pm 10\%$ input variations, transfer circuit, solid-state modular low voltage disconnect to operate at 80% battery output voltage, and a suitable length of 3-wire power cord with "twist-

-
- lock" plug
 - .5 signal lights for "AC POWER ON" and red "HIGH CHARGE", an ammeter and a voltmeter, a test switch, time delay relay, battery disconnect device, RFI suppressors, and AC input and DC output terminal blocks inside the cabinet
 - .6 cabinet mounted, dual, adjustable (345° horizontal and 180° vertical) lamp heads, integral with the cabinet and/or remote mounting as indicated, each complete with a 13 watt tungsten-halogen glare-free lamp
 - .7 Lumacell Inc. Model MT1 remote surface mounted lamp head with a 12 volt DC 9 watt tungsten-halogen lamp
 - .8 Lumacell Inc. Model MT1 remote recess mounted lamp head with a 12 volt DC 25 watt tungsten-halogen lamp
 - .9 where indicated, a wire guard
 - .2 Acceptable manufacturers are:
 - .1 Lumacell Inc.
 - .2 Emergi-Lite Ltd.
 - .3 Hubbell Inc. "Dual-Lite"
 - .4 Philips "LightGuard"
 - .5 Beghelli
 - .6 Approved Equivalent

3 EXECUTION

3.01 INSTALLATION OF SELF-CONTAINED EMERGENCY LIGHTING UNITS

- .1 Provide self-contained emergency lighting units where shown. Include for all required site assembly, provide all required installation and support hardware, and plug the assemblies into adjacent receptacles. Confirm exact locations prior to installation.
- .2 Where remote lamp heads are indicated, install and connect to the battery unit with conductors (sized as indicated) in conduit. Ensure that panelboard breakers serving battery units are equipped with lock-on devices.
- .3 Connect exit light 12 volt DC lamp holders to battery units with wiring in conduit as indicated.
- .4 Provide all required lamps.
- .5 Aim all adjustable lamp heads to the Consultant's approval.
- .6 When all installation work is complete, clean all battery units, lamp heads, and lamps, and any ceiling, wall, etc., surfaces soiled as a result of the installation work.

- .7 If wall and ceiling surfaces are damaged as a result of the installation, replace the wall or ceiling surface to the Consultant's approval.
- .8 Test operation of each battery unit, including charge rate after discharge, in the presence of the manufacturer's representative, and submit a letter from the manufacturer's representative to certify that all battery units and lamp heads have been tested and operate as intended.

END OF SECTION

1 GENERAL

1.01 SUBMITTALS

- .1 **Shop Drawings/Product Data:** Submit product data sheets for exit lighting fixtures.

1.02 QUALITY ASSURANCE

- .1 All exit lighting fixtures are to be CSA certified in accordance with:
 - .1 CAN/CSA- C22.2 No. 141, Unit Equipment for Emergency Lighting
 - .2 CAN/CSA- C860, Performance of Internally-Lighted Exit Signs

2 PRODUCTS

2.01 EXIT LIGHTS

- .1 Recessed, wall end to wall, or ceiling mounted, single or double face exit lights as indicated, complete with directional arrows as shown, 120 volt maximum five watt LED'S designed for a minimum of 50,000 hours of continuous operation without re-lamping and located so as to be visible, all required mounting accessories, and the following:
 - .1 an average exit legend illumination level of 15 cd/m²
 - .2 an emergency power source
 - .3 unless otherwise specified, a 1.0 mm (1/25") thick satin aluminium, enamel finish cold rolled steel, or brush finish extruded or die-cast aluminium housing, all as per the drawing schedule
 - .4 unless otherwise specified, white enamelled die-formed cold rolled steel or cast aluminium alloy back and/or face plates, as per the drawing schedule
 - .5 minimum 150 mm (6") high, 20 mm (¾") wide red "EXIT" lettering, or "EXIT" and "SORTIE" lettering as specified
 - .6 a white glass or translucent acrylic downlight in the bottom of the fixture
 - .7 a third lamp socket for an emergency lamp lighting circuit
 - .8 a wire guard where indicated
 - .9 for self-powered exit lights, a dust-tight relay transfer and maintenance free nickel- cadmium battery with low voltage disconnect, charger, high charge rate and brownout features
 - .10 for water-proof exit lights, a gasketed water-tight housing

.2 Acceptable Manufacturers: Acceptable manufacturers are:

- .1 Lumacell Inc.
- .2 Emergi-Lite Ltd.
- .3 Hubbell Inc. "Dual-Lite"
- .4 Luxnet Corp.
- .5 Beghelli
- .6 Approved Equivalent

3 EXECUTION

3.01 INSTALLATION OF EXIT LIGHTS

- .1 Provide exit lights where shown. Include for all required site assembly, and provide all required installation and support hardware.
- .2 Confirm exact exit light locations prior to roughing-in, and in any case, ensure that exit lights are not less than 2 m (6½') from the underside of the fixture to the finished floor.
- .3 For ceiling mounted exit lights in areas with unfinished ceilings, mount the fixture alongside a junction box, with or without canopy, and connect the fixture laterally with conduit (or with embedded conduit where permitted or specified) or by using the exit light canopy as a junction box where permitted.
- .4 Connect exit lights to circuits indicated with wiring as specified. Install wiring in conduit. Ensure that panelboard breakers serving exit lights are equipped with lock-on devices.
- .5 Connect emergency power sockets to the emergency power source as indicated and/or specified.
- .6 Provide all required lamps. Lamps are specified in the Section entitled Ballasts, Lamps, Lenses and Louvres.
- .7 When all exit light installation work is complete, clean all fixtures and lamps, and any ceiling, wall, etc., surfaces soiled as a result of the installation work.
- .8 If wall and ceiling surfaces are damaged as a result of the installation, replace the wall or ceiling surface to the Consultant's approval.

END OF SECTION

1 GENERAL

1. The purpose of the grounding system is to create a low impedance path to earth ground for electrical surges and transient voltages. Lightning, fault currents, circuit switching (motors turning on and off), and electrostatic discharge are common causes of these surges and transient voltages. An effective grounding system minimizes the detrimental effects of these electrical surges, which include degraded network performance and reliability and increased safety risks.
2. The grounding system must be intentional, visually verifiable, adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment. As such, grounding must be purposeful in its design and installation. Four issues require special consideration:
 - 2.1 Although AC powered equipment typically has a power cord that contains a ground wire, the integrity of this path cannot be easily verified. Thus, many equipment manufacturers require grounding above and beyond that which is specified by local electrical codes, such as the National Electrical Code, etcetera. Always follow the grounding recommendations of the manufacturer when installing equipment.
 - 2.2 While the building steel and metallic water piping must be bonded to the grounding system for safety reasons, neither may be substituted for the telecommunications bonding backbone (TBB).
 - 2.3 Electrical continuity throughout each rack or cabinet is required to minimize safety risks. Hardware typically supplied with bolt-together racks is not designed for grounding purposes. Additionally, most racks are painted. Paint is an insulator. Unless rack members are deliberately bonded, continuity between members is incidental, and in many cases, unlikely.
 - 2.4 Any metallic component that is part of the data center, including equipment, racks, ladder racks, enclosures, cable trays, etc. must be bonded to the grounding system
3. Provide grounding & bonding in accordance with good industry practices and in accordance with the following codes and standards.
4. The ground system must be designed for high reliability. Therefore, the grounding system shall meet following criteria:
 - CSA Standard C22.2 No.41-M1987 – Grounding & Bonding Equipment
 - CSA Standard T527 (ANSI/TIA/EIA-607)
 - CSA Standard T 530 - Telecommunications Pathways and Spaces
 - Ontario Hydro Electrical Safety Code
 - Ontario Building Code
 - Local Codes & Bylaws
 - BICSI requirements

5. Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and CSA Certified and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.
6. All grounding conductors shall be copper
7. Wherever possible, two-hole lugs shall be used because they resist loosening when twisted (bumped) or exposed to vibration. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion (battery rooms are an exception where windowless lugs may be used).
8. Die index numbers shall be embossed on all compression connections to allow crimp inspection.
9. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.

2 PRODUCTS

TBB Sizing

1. The Telecommunications Grounding Busbar (TGB) in each telecommunications space will be grounded to the Telecommunications Main Grounding Busbar (TMGB) located at the service entrance. The gauge of the connecting ground cable, known as the Telecommunications Bonding Backbone (TBB) will follow J-STD-607-A guidelines, as is shown in the table below.

Sizing of the TBB	
TBB Length in Linear meters (feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
Greater than 20 (66)	3/0

Busbars

Part Number	Bar Size	No. of 5/16" hole sets, 5/8" spacing	No. of 7/16" hole sets, 1" spacing	Std. Pkg. Qty.
Telecommunications Grounding Busbars (TGB)				
GB2B0304TPI-1	¼" x 2" x 10"	4	3	1
GB2B0306TPI-1	¼" x 2" x 12"	6	3	1
GB2B0312TPI-1	¼" x 2" x 20"	12	3	1
Telecommunications Main Grounding Busbars (TMGB)				
GB4B0612TPI-1	¼" x 4" x 12"	4	3	1
GB4B0624TPI-1	¼" x 4" x 20"	6	3	1

Copper Code Cable Sizes

- The TMGB will be bonded to building steel and grounded to the electrical service ground according to BICSI TDM Manual and J-STD-607-A guidelines. Local codes may supersede these requirements. In telecommunications spaces with only one rack, the rack jumper cable can be connected directly to the TGB.

Cable Sizes for Other Grounding Applications	
Purpose	Copper Code Cable Size
Aisle grounds (overhead or under floor) of the common bonding network	#2 AWG or larger (1/0 preferred)
Bonding conductor to each PDU or panel board serving the room.	Size per NEC 250.122 & manufacturer recommendations
Bonding conductor to HVAC equipment	6 AWG
Building columns	4 AWG
Cable ladders and trays	6 AWG
Conduit, water pipe, duct	6 AWG

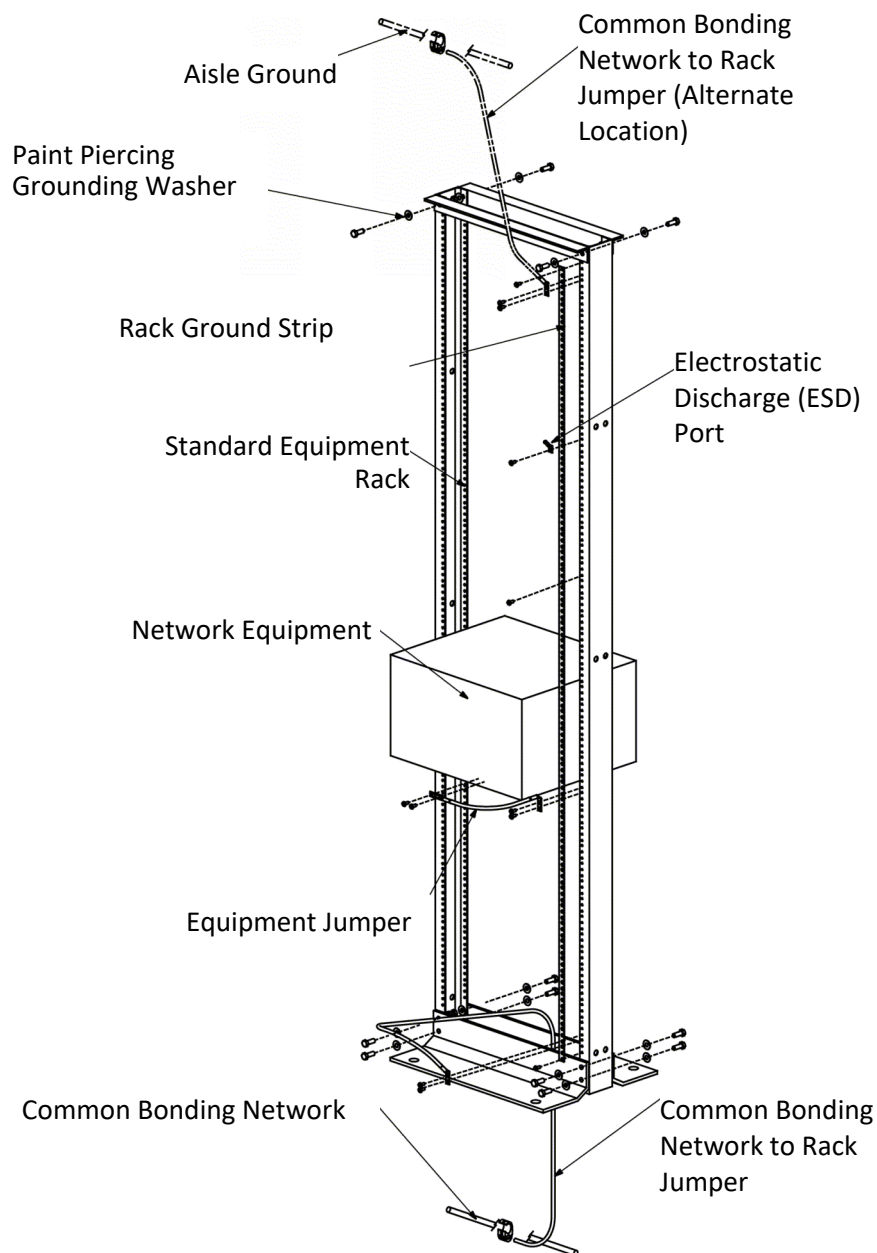
3 EXECUTION

3.01 INSTALLATION

- PANDUIT STRUCTUREDGROUND* grounding system or approved equivalent, kits, components, and hardware shall be used to construct the grounding/earthing system.
- Use PANDUIT GB4 series BICSI/J-STD-607-A telecommunications grounding busbars for the TMGB, which is ideally located at the AC service entrance. Use a PANDUIT GB2 series busbar for the TGB in each of the other telecommunications/equipment spaces throughout the building. Use PANDUIT LCC-W series lugs when connecting conductors to the TMGB and TGB.
- Route the TBB to each TGB in as straight a path as possible. The TBB should be installed as a continuous conductor, avoiding splices where possible. Use PANDUIT HTAP kits, family HTWC, to provide a tap from the TBB to each TGB. When more than one TBB is used, bond them together using the TGBs on the top floor and every third floor in between with a conductor known as a grounding equalizer (GE). Use the J-STD-607-A guidelines for sizing of the TBB when sizing the GE (shown in the table above).
- Avoid routing grounding conductors in metal conduits. If the grounding conductor must be routed through a metal conduit, bond each end of the conduit to the grounding conductor. Use PANDUIT GPL series grounding clamps to bond to the conduit, a PANDUIT HTWC HTAP with clear cover to bond to the grounding conductor, and a #6 AWG copper conductor to connect the GPL grounding clamp to the HTWC HTAP.
- Equipment and racks shall be bonded in accordance with the methods prescribed in ANSI/TIA-942 draft 7.0 as shown in figure below. To provide electrical continuity between rack elements, PANDUIT paint piercing grounding washers, series RGW, shall be used where

rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.

6. All racks shall utilize a full-length rack ground strip, PANDUIT part number RGS134, attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact.
7. Mount an electrostatic discharge (ESD) port kit, PANDUIT part number RGEDS-1 directly to the rack grounding strip on the back of the rack at approximately 48 inches from the floor. Mount a second RGEDS-1 directly to the vertical mounting rail of the rack in the front at approximately the same height. Use the thread-forming screws provided to form a bond to the rack. Place the ESD protection identification stickers directly above the ESD ports.
8. When the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. Use the appropriate PANDUIT RG series jumper for the equipment being installed and the thread-forming screws provided in the kit.
9. Use PANDUIT part number **RGCBNJ660P** (Common Bonding Network to Rack Jumper) to attach the rack ground strip to the common bonding network. Do not bond racks or cabinets serially. Use the copper compression HTAP that comes with the kit to bond the conductor to the common bonding network.
10. Patch panels will be bonded to racks using the PANDUIT bonding screws, part number **RGTBS-C** for racks having #12-24 equipment mounting holes, and **RGTBSM6-C** for racks having M6 equipment mounting holes.



END OF SECTION

1 GENERAL

1.1 General

1. Division 26 specification documents shall be followed in conjunction with the following specs.
2. The Telecommunications Cabling Contractor shall not use any mechanical or electrical fittings to support the telecommunications cabling. All telecommunications cabling shall be independently supported.
3. The Telecommunications Cabling Contractor shall independently support the cables above all ceiling tiles and in a manner where the cables do not interfere with the removal of the ceiling tiles. A minimum of 75 mm 3"(in) of clear vertical space above the ceiling tiles shall be maintained.
4. The General Contractor/Project Manager/The Consultant must approve all deviations from the contract documents and drawings in relation to cable routing, outlet and equipment locations.

1.2 Hangers

1. Anchors for hangers must not be drilled into post-tensioned beams under any circumstances.
2. The Telecommunications Cabling Contractor is responsible for coordinating the best time to install the anchors with the General Contractor/Project Manager/The Consultant. After hours work may be required for this portion of the work.
3. Hangers & supports shall be sized to accommodate the number of cables in each run. Other hardware such as hammer on clamps, screw on clamps and angled hanger brackets to support the backbone and/or horizontal cabling shall be included.

1.3 Conduit

1. Division 26 specification documents shall be followed in conjunction with the following specs.
2. Electrical Metallic Tubing (EMT) of the sizes indicated shall be installed.
3. Conduit extending from outlet to cabletrough/raceway shall be a minimum of 1"(in) unless the cables exceed a 40% fill ratio.
4. No EMT shall be smaller than 1"(in) unless specifically detailed in this document.
5. No more than two - 90° bends in conduit between pull points. Provide a pull box for every 30 m 100'(ft) of conduit. Pull boxes are not to be used as bends.
6. Conduits of 50mm 2"(in) or less to have a bend radius of six (6) times the conduit diameter. A conduit greater than 50mm 2"(in) to have a bend radius of ten (10) times the conduit diameter.
7. Bush, ream and remove any sharp projections on all conduits.
8. All conduit shall be labelled at each end indicating the destination.
9. Run all conduit parallel or perpendicular to building grid lines.

10. Slots and sleeves to extend a minimum of 50 mm 2"(in) above the finished floor.
Conduits shall protrude a minimum of 76 mm 3"(in) into rooms through walls.
11. Conduits shall not compromise existing HVAC ducting or sheet metal work.
12. Division 26 specification documents shall be followed in conjunction with the following specs.
13. Innerduct shall be sized appropriately to maintain the 40% fill ratio and allow for a proper bend radius of the cable(s) within.
14. Acceptable Manufacturers:

<u>Size</u>	<u>Non-Plenum Orange</u>	<u>Non-Plenum Yellow</u>
1"	Panduit Part# CLT125F-L3....	Panduit Part# CLT150F-X4
2"	Panduit Part# CLT188F-X3	Panduit Part# CLT188-X4

1.4 Cable Trough

1. Division 26 specification documents shall be followed in conjunction with the following specs.
2. The Telecommunications Cabling Contractor shall be responsible for coordinating the installation with Division 26.
3. Cable trough shall be sized (including 10% growth) as per the drawings and will accommodate all horizontal and/or backbone cabling within the Telecommunications Room as well as entering/existing the Telecommunications Room.
4. All material to properly install the cable trough shall be provided. The cable trough system shall accommodate the weight of the horizontal and/or backbone cabling including 10% growth.
5. Provide horizontal elbows, end plates, vertical risers and drops, tees, wyes, expansion joints and reducers where required.

2 PRODUCTS

2.1 Hangers

<u>Description</u>	<u>Panduit Part#</u>
Wall Mount	JP2W-L20
Ceiling Mount	JP2CM-L20
Drop Wire & Threaded Rod Clip	JP2DW-L20
Screw-On Beam Clamps	JP2SBC50-L20 or JP2SBC50R-L20
Hammer On Beam Clamps	JP2HBC25R-L20 or JP2HBC50R-L20 or JP2HBC75R- L20
Purlin Clips	JP2ZP-L20 or JP2CP-L20
Under Floor Pedestal Support Clamp	JP2UF100-L20

2.2 Conduit Fastening

1. One hole malleable iron, hot dipped galvanized straps to secure surface mounted conduits.
2. Beam clamps to secure conduits to exposed steel members.

3. Provide 12 gauge galvanized steel channel type supports for two or more conduits on minimum 1500 mm centres. Use suitable conduit clamps in channel.
4. Threaded rod with a minimum dia. of 6mm shall be used to support the suspended channels.
5. Gray flame retardant polyethylene Threaded Rod Covers shall be installed to protect the cables from abrasion. **Panduit Part# TRC18FR-X8.**

2.3 Conduit Fittings

1. Fittings manufactured for use with the conduit specified with the same coating as conduit.
2. Provide insulated steel Rain Tight connectors and couplings for all EMT conduits 50 mm 2"(in) and smaller.
3. All 4"(in) conduit shall have conduit water falls installed. **Panduit Part# CWF400.**

3 EXECUTION

3.01 INSTALLATION

1. The Telecommunications Cabling Contractor shall run all pathways including conduits, innerduct and cable trough parallel or perpendicular to building lines.
2. The Telecommunications Cabling Contractor shall maintain the following minimum clearances from electrical and heat sources when routing copper cables.

Item	Minimum Separation Distances		
	(<2kVA)	(2-5kVA)	(>5kVA)
Unshielded power lines or electrical equipment in proximity to open or non-metallic pathway.	127 mm (5"(in))	305 mm (12"(in))	610 mm (24"(in))
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	64 mm (2.5"(in))	152 mm (6"(in))	305 mm (12"(in))
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	---	76 mm (3"(in))	152 mm (6"(in))
Motors	1.2 m (4'-0")		
Transformers	1.2 m (4'-0")		
Conduit and cables used for electrical distribution less than 1kV	0.3 m (1'-0")		

Conduit and cables used for electrical distribution greater than 1kV	1.0 m (3'-0")
Fluorescent Luminaires	300 mm (12")
Pipes (gas, oil, water, etc.)	120 mm (5")
HVAC (equipment, ducts, etc.)	150 mm (6")

3. Supply and install Caddy hangers, hanger supports and any other miscellaneous hardware required to support telecommunications cabling where conduit/ladder tray has not been provided.
4. Panduit J-Pro hangers are to be used every 4'(ft) 1.2 m.
5. All conduit shall have 3mm polypropylene, minimum, fish cords installed.
6. Supply and install innerduct along the full length of the fibre optic cable.
7. The innerduct shall be fastened to the building support when installed in the ceiling space.
8. The innerduct shall be fastened to the backboard, rack or cabinet by utilizing cradle mounts and plastic permanent cable ties.
9. Install cable tray as indicated on the drawings.
10. Support cable tray every 10'(ft).
11. All sharp burrs and projections to prevent damage to cables, ladders or personnel.

End of Section

1 GENERAL

1.01 GENERAL

1. Adhesive cable labels to meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition, the labels shall meet the general exposure requirements in UL 969 for indoor use.
2. Self-laminating vinyl construction cable labels with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.
3. CSA T528 9(ANSI/EIA/TIA-606) for colour codes shall be followed. Labels are to be mechanically printed using a laser printer. Hand written labels will not acceptable.

2 PRODUCTS

1. PanAcea – LS7 hand-Held Printer. Part# LS7 or PanAcea – LS8 hand-Held Printer. Part# LS8.
2. Easy-mark labeling software. Part# PROG-EMCD.
- .3 Approved equivalent.

3 EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

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

3.02 INSTALLATION

1. Cable identification labels should appear at the following locations with the numbers indicated on the cable schedule and drawings:
 - 102 mm 4”(in) from each end of the cable – after termination.
 - Front of patch panels.
 - Front of IDC termination blocks.
 - Front of workstation/communications outlet faceplates.
 - Each end of each Telecommunications Conduit.
2. Fibre Optic safety Labels shall appear at the following locations:
 - Along the length of the conduit or innerduct at 3m 10’(ft) intervals.
 - At all junction boxes
 - At all pull boxes.
 - On all fibre optic patch panels.

3. Provide 25% additional labels to be left in each telecommunications room on site for future growth.

Horizontal Cables

1. Refer to Division 26

END OF SECTION

1 GENERAL

1.01 GENERAL

1. The Consultant shall withhold 15% of the telecommunications project value from the Telecommunications Cabling Contractor until all accurate close-out documentation is forwarded to the General Contractor/Construction Manager or The Consultant. In addition, this value will be withheld until all deficiencies are resolved.
2. Upon completion of the testing, the Consultant may ask the Telecommunications Cabling Contractor to perform a random test of up to 10% of the cables.
3. All deficiencies must be corrected before the Consultant will forward authorization to release the Holdback.

2 EXECUTION

2.01 INSTALLATION

1. Bi-directional testing of all horizontal Category 3 backbone copper cables are to be completed in accordance with the follow test criteria:
 - continuity
 - shorts
 - opens
 - grounds
 - correct
 - length
2. Testing of all horizontal Category 6 copper cables are to be completed in accordance with the follow test criteria:
 - Basic Link
 - continuity
 - shorts
 - opens
 - grounds
 - correct polarity
 - length
 - attenuation
 - NEXT
 - PSNEXT
 - ACR
 - PSACR
 - ELFEXT
 - PSELFEXT
 - Return Loss
 - resistance
3. Fibre strands in excess of 122m 400'(ft) shall be tested with an Optical Time Domain Reflectometer for length and attenuation.
4. Test each stand of fibre, bi-directionally, with a Power Meter / Light Source combination operating at wavelengths of 850 nm and 1300 nm for multimode fibres.
5. Maximum multi-mode passive link loss (including patch cords) is not to exceed - 2.35dB.
6. Maximum single-mode passive link loss (including patch cords) is not to exceed - 1.0dB.

2.02 DOCUMENTATION

1. The Telecommunications Cabling Contractor is required to submit test results in native tester format or a format which can be read with a text reader (i.e. ".txt" extension). Paper results shall not be submitted for projects with 100 or more horizontal cable drops and/or fibre cables.
2. The Telecommunications Cabling Contractor is required to provide the software required to view the results.
3. The report should be divided into sections by Telecommunications Room.

4. The report should indicate for each cable when it was tested successfully, the result, and the length.
5. The Telecommunications Cabling Contractor shall sign off on the entire test report prior to submitting to the General Contractor/Construction Manager or The Consultant.
6. The test result documentation is to be submitted to the General Contractor/Construction Manager or The Consultant for review no later than ten (10) working days following the completion of the installation.
7. All deficiencies must be corrected before the General Contractor/Construction Manager or The Consultant will provide a certificate to release the Holdback on the project.
8. Record Drawings
9. The Telecommunications Cabling Contractor is required to maintain one (1) set of correct and accurate record drawings on-site at all times. These drawings are to be made available to the General Contractor/Construction Manager or the Consultant for review during the project.
10. The Telecommunications Cabling Contractor is required to provide record drawings of the telecommunication cabling installation in relation to the drawings provided in this specification.
11. The record drawings shall be updated electronically and include, but are not limited to;
 - Horizontal cable numbers on the floor plans
 - Horizontal Cable Routing on the floor plans
 - Changes on the floor plans
 - Backbone cable Routing between Telecommunications Rooms
 - Paging Speaker Locations including daisy chain cable run
 - Wireless Access Points and Cell coverage
 - Cabinet/Rack Elevation drawings
 - Backboard Elevation Drawing
12. The Telecommunications Cabling Contractor shall provide one (1) soft copy in AutoCAD 2010 and one (1) plotted copy for the General Contractor/Construction Manager or The Consultant to review prior to complete close-out documentation submission.
13. After approval, the Telecommunications Cabling Contractor shall submit one (1) plotted copy of the drawings for;
 - The Main Computer Room
 - Each Telecommunications Room
 - The Consultant
14. All close-out documentation must be submitted to the Consultant within ten (10) working days of the completion of the project before the documentation holdback will be released.

END OF SECTION

1 GENERAL

1.01 CABLE MANAGEMENT

1. The Cable Management System shall be used to provide a neat and efficient means for routing and protecting fiber and copper cables and patch cords on telecommunication racks and enclosures. The system shall be a complete cable management system comprised of vertical cable managers, horizontal cable manager, and cable management accessories used throughout the cabling system. The system shall protect network investment by maintaining system performance, controlling cable bend radius and providing cable strain relief.

2 PRODUCT

2.01 RACKS

1. The Rack system shall meet all EIA requirements as defined EIA-310-D.
2. Racks as indicated on plans.

2.02 VERTICAL CABLE MANAGEMENT

1. Vertical cable managers shall include components that aid in routing, managing and organizing cable to and from patch panels and/or equipment. Managers shall protect network equipment by controlling cable bend radius and providing cable strain relief. Managers shall be a universal design mounting to EIA 19" or 23" racks and constructed of a base with cable management fingers. The fingers shall include retaining tabs to keep cables in place during cover removal. The covers shall be hinged to open in either direction allowing for quick moves, adds, and changes.

PART # or Approved Equals	Type	Rack Spaces	Type	Max. Side Extension
PRV12	Front and Rear	45	High Capacity	12.0
PRVF12	Front only	45	High Capacity	12.0
PRD12	Hinged Door	-	-	12.0
PRV8	Front and Rear	45	Standard	8.0
PRVF8	Front only	45	Standard	8.0
PRD8	Hinged Door	-	-	8.0
PRV6	Front and Rear	45	Standard	6.0
PRVF6	Front only	45	Standard	6.0
PRD6	Hinged Door	-	-	6.0
PRSP5	Rear Slack Spool, 5"	-	-	-
PRSP7	Front Slack Spool,	-	-	-

3 EXECUTION

1. Install racks and cable management in communication room(s) as indicated on drawings.

END OF SECTION

1 GENERAL

1.01 TERMINATION EQUIPMENT

1. All termination mounts shall be fully loaded with the appropriate connectors.
2. Blank labeling strips are required for connectors that are not in use.
3. IDC block quantities shall accommodate the number of terminated cable pairs.
4. IDC 250-pair and 300-pair blocks shall be complete with labeling strips.
5. Material and equipment shall be new, and conform to grade, quality and standards specified.
6. Backboard layout will be as per manufacturer's recommendations unless expressly written otherwise by the General Contractor/Construction Manager or the Consultant

2 PRODUCT

2.01 CATEGORY 6 ANGLED PATCH PANEL

1. *MINI-COM*® Angled Modular Faceplate Patch Panels or approved equivalent shall allow cable to flow to each side of the rack and shall eliminate the need for horizontal cable managers by enabling patch cords to be routed directly into vertical cable managers. The angled design shall allow the labeling scheme and port identification to be visible at all times.

Vertical cable managers in the *PANDUIT*® PatchRunner Cable Management System or approved equivalent shall utilize moulded cable management fingers and integral bend radius control. These features coupled with the Angled Patch Panels shall provide the ultimate high-density cable management system.

Part Number	Number of Ports	Rack Spaces
CPPLA24WBL	24	1
CPPLA48WBL	48	2

MINI-COM® High Density Modular Faceplate Patch Panels or approved equivalent

Part Number	Description	Number of Ports	Rack Spaces
DPA24688TGY	Cat 6	24	1
DPA48688TGY	Cat 6	48	2

MINI-COM® High Density 110 termination Back Panel Patch Panels or approved equivalent

Panduit Minicom TX6 Plus Category 6 Module

Part Number	Style	Configuration	Category	Colors
CJ688TG**	RJ45	Universal	6	11

** Designates color

2. Colours:

- i. Phone: White
- ii. Data: Blue

Panduit Opticom Rack Mount Fibre Optic Enclosures

1. Can be mounted to any standard 19" or 23" EIA rack or cabinet.
2. Includes fiber optic cable routing kits (grommets, cable ties, saddle clips, spools, strain relief and ID/caution labels) for various cable management solutions.
3. Multiple cable entry locations provided in rear of enclosure on top, bottom, and side
Holds Opticom® or approved equivalent Fiber Adapter Panels.
4. Durable molded hinged front and rear lockable doors

Part Number or approved equals	Rack Spaces
FRME1	1
FRME2	2
FRME3	3

Frames for Modular Jacks

1. Frames shall be 4-port Frames which will accommodate RJ45 Style, RJ12, ST Compatible or SC jacks.
2. Where applicable, use recessed blanks for all unused ports. Blanks to match Frame colour.

Part #: 4-portCFG4** (** denotes colour)

3. Colour: IW (International White).

SC OptiCam Fibre Optic Connector

1. PANDUIT or approved equivalent ® OPTI-CAM or approved equivalent ® LC Fiber Optic Connectors shall be field terminable (mechanical crimp termination) simplex fiber optic connectors for multimode glass fiber that fully complies with the fiber optic connector performance requirements specified in TIA/EIA-568-B.3 and the intermatibility requirements specified by the TIA 604-2 FOCIS-2 document.

Part Number	Style	Fiber Type	Termination	Simplex/ Duplex	Colour
FLCSMCXAQY	LC	10 Gig 50/125µm Multimode 3mm jacketed	Pre-polished, mechanical crimp	Simplex	Aqua
FLCDMCXAQY	LC	10 Gig 50/125µm Multimode 3mm jacketed	Pre-polished, mechanical crimp	Duplex	Aqua

3 EXECUTION

3.01 INSTALLATION

1. Refer to Section 27 15 00 Horizontal Cabling.

END OF SECTION

1 GENERAL

1.01 GENERAL

1. The Telecommunications Cabling Contractor shall ensure ANSI/EIA/TIA-568-B installation practices are followed.
2. The Telecommunications Cabling Contractor shall terminate all pairs of cable. Terminate all spare cables at the Telecommunication Room end.
3. The Telecommunications Cabling Contractor shall run all horizontal cables parallel to building grid lines with no splices.
4. Provide 3m (10'-0") of slack at the workstation end of the cable to permit future outlet relocation. Neatly coil slack in ceiling space or on the side of the cable tray.
5. Provide 1m (3'-0") of slack at the Telecommunications Room end of the cable to permit future relocation. Neatly coil the cable in the cable tray or in the ceiling space.
6. Inform The Consultant immediately of any horizontal cable runs exceeding 90 m 295' (ft.).
7. When terminating copper cables remove cable jacket only enough to perform termination and untwist pairs a maximum of 13 mm (1/2") for Category 6 cables.
8. The Consultant shall determine the quality of workmanship during installation. Cables that have not been properly installed will be reinstalled by the Telecommunications Cabling Contractor at no additional expense to the client.
9. Maintain a minimum of four (4) times cable diameter as a bend radius if no bend radius is specified.

2 PRODUCT

2.01 CATEGORY 6 CABLES

1. Data - 4-pair UTP cable shall exceed Category 6A requirements per ANSI/TIA/EIA-568-B.
2. The PANDUIT or approved equivalent[®] TX Copper Plenum Rated Cable or approved equivalent shall be used for the horizontal cabling subsystem. These requirements are for cables of unshielded 24 AWG bare copper conductors, insulated with thermoplastic, twisted into pairs and enclosed in a thermoplastic jacket. The finished cable shall meet or exceed the following requirements of ANSI/EIA/TIA-568-B.
3. All cable shall conform to the requirements for communications circuits defined by the National Electrical Code (Article 800) and the Canadian Building Code. Cable listed to NEC Article 800-51(a) will be used for "Plenum" installations and carry labeling of CMP. Cable listed to NEC Article 800-51(b) shall be installed in vertical runs penetrating more than one floor and carry the labeling of CMR.

Part # or approved equal	Category	Colours
PUP6004**-U	6 Plenum	4

** Denotes colour

-
4. Colour:
 - a. Phone: White
 - b. Data: Blue

3 EXECUTION

3.01 INSTALLATION

1. All horizontal cables shall be bundled on the Telecommunications Racks using Panduit Velcro straps or approved equivalent. Bundles shall be wrapped at a maximum of 203 mm 8" (in) separation.
2. All exposed cabling at the workstation between wall/floor-input point locations and systems furniture are to be wrapped with Panduit Pan-Wrap Split Harness Wrap or Panduit Polyethylene Spiral Wrap or approved equivalent, size and length as required to suit.
3. Provide blank filler plates for all unused modular jack positions on faceplates.
4. Supply and install Category 6 CMP cables to the outlets outlet indicated on the drawings. The Telecommunications Cabling Contractor shall refer to the legends on the drawing to determine the number of cables to each outlet location.
5. Terminate test and label each Cat6 cable in accordance to the parameters stated in this specification document.

END OF SECTION

1 GENERAL

1.01 GENERAL

1. None.

2 PRODUCT

2.01 Panduit TX6 Plus Category 6 Patch Cord (Data) or approved equivalent

1. Category 6 Patch Cords shall be factory terminated with enhanced performance Pan- Plug TM modular plugs featuring a one-piece, tangle-free latch design eliminating the need for strain-relief boots to provide easy moves, adds and changes. Each patch cord shall be 100% verified for wiring sequence and continuity at the factory. The patch cords shall come in standard lengths of three, five, seven, 10 14, and 20 feet and six standard colors of Off White, Black, Blue, Green, Red and Yellow.

Part Number or approved equals	Length (ft)	Length (M)
UTPSP3**	3	0.91
UTPSP5**	5	1.52
UTPSP7**	7	2.13
UTPSP10**	10	2.74
UTPSP14**	14	4.27
UTPSP20**	20	6.10

** Designates colour

2. Provide a 7' patch cord for each data outlet indicated on the drawings.
3. Colour:
 - .1 Phone: White
 - .2 Data: Blue

Fiber Optic Patch Cords

1. Dual fiber optic patch cables to meet same performance criteria as fiber optic cabling.
2. Cables to be FL Plug to an SC.
3. Connectors to be;

Part # or approved equal	Category	Plug Config	Length
FXE10-10M3Y	10G 50/125 μ m	LC to LC	10'-3m

4. Patch cords positions (i.e. A & B) to be in accordance with ANSI/TIA/EIA-568-B.3.
5. Colours: Multimode: Aqua

3 EXECUTION

3.01 INSTALLATION

1. Refer to Section 27 15 00 Horizontal Cabling for quantities and installation details.

END OF SECTION

1 GENERAL

REFERENCES

- .1 Abbreviations:
 - .1 Electronic Access Control (EAC): control of people through entrances and exits of controlled area. Security utilizing hardware systems and specialized procedures to control and monitor movements within a controlled area.
 - .2 CPVX: Central Station Burglar Alarm Systems.
 - .3 CVSG: Mercantile Burglar Alarm Systems.
 - .4 CVWX: Proprietary Burglar Alarm Systems.
 - .5 DRS: Door Release System.
 - .6 PIN: Personal Identification Number.
- .2 Reference Standards:
 - .1 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S301-09, Standard for Signal Receiving Centre Burglar Alarm System and Operations
 - .2 CAN/ULC-S302-M91(R1999), Standard for Installation and Classification of Burglar Alarm Systems for Financial and Commercial Premises, Safes and Vaults.
 - .3 CAN/ULC-S304-06, Signal Receiving Centre and Premise Burglar Alarm Control Units.
 - .4 CAN/ULC-S310-M91(R1999), Installation and Classification of Residential Burglar Alarm Systems.
 - .5 ULC-S318-96, Standard for Power Supplies for Burglar Alarm Systems.
 - .6 ULC-C634-86, Guide for the Investigation of Connectors and Switches for Use with Burglar Alarm Systems.
 - .3 Underwriters' Laboratories (UL)
 - .1 UL 294-2009, Access Control System Units.
 - .2 UL 603-08, Power Supplies for Use with Burglar Alarm Systems.
 - .3 UL 681-1999, Installation and Classification of Burglar and Holdup Alarm Systems.
 - .4 UL 827-2008, Central-Station Alarm Services.
 - .5 UL 1023-2009, Household Burglar Alarm System Units.
 - .6 UL 1076-2005, Safety for Proprietary Burglar Alarm Units and Systems.
 - .7 UL 1641-1999, Safety for Installation and Classification of Residential Burglar Alarm Systems.

1.02 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 access controls and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures.
 - .3 Submit:
 - .1 Functional description of equipment.
 - .2 Technical data for all devices.
 - .3 Device location plans and cable lists.
 - .4 Devices mounting location detail drawings.
 - .5 Typical devices connection detail drawings.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Shop drawings to indicate project layout, including details.
 - .1 Shop drawings to indicate, mounting heights and locations, wiring diagrams.
 - .2 Submit zone layout drawing indicating number and location of zones and areas covered.
 - .3 Submit wiring diagrams.
 - .4 Submit complete equipment list.
- .4 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Samples will be returned for inclusion into work.
 - .3 Submit 1 sample of each component proposed for inclusion into system.
Components will be returned for incorporation into work.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .1 Submit ULC/UL Product Safety Certificates.
 - .2 Submit verification Certificate that service company is ULC/UL List alarm service company.
 - .3 Submit verification Certificate that monitoring facility is ULC/UL "Listed central station".
 - .4 Submit verification Certificate that security access system is "Certified alarm system".
- .6 Test and Evaluation Reports:
 - .1 Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .7 Manufacturer's Instructions: submit manufacturer's installation instructions.
- .8 Manufacturer's Field Reports: submit manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.03 WARRANTY

- .1 Project Warranty: refer to Section 1 for project warranty provisions.
- .1 .2 Manufacturer's Warranty: submit, for Consultant's acceptance, manufacturer's standard warranty document executed by authorized company official.

2 PRODUCTS

MATERIALS

- .1 Design Criteria:
 - .1 Design access control and security access systems using only ULC/UL listed products.
 - .2 Design security access system using ULC/UL listed alarm service company, company specializing in security access systems.
 - .3 Design security access system as a non certified alarm system
 - .4 Design access control systems to meet safety requirements to UL 294.
 - .5 Design system to provide door manual and automatic control functions from locations indicated to central monitoring system.
 - .6 Design system to allow for addition of future Door Release System (DRS) controls and activation units by adding appropriate transmission lines and equipment at each location.
 - .7 Design system to consist of homed run control to activation unit connections.
 - .8 Each activation unit must have door panel control function/equipment item located as indicated.
 - .9 Design system to provide ease of operation, servicing, maintenance, testing and expansion of additional services.
- .10 Door activation units:
 - .1 Fully complement and function and match door manufacturer's magnetic controls and hardware.
 - .2 Fully function with OEM supplied door controls and hardware to activate system in routine and emergency conditions.
 - .3 Fully function within supplied electrical supervision circuits as specified.
- .11 Control Panel:
 - .1 Fully compatible, compliment and operate door magnets provided by door manufacturer of system or OEM supplied door operating hardware.
 - .2 Complete with push button or electronic key pad to release and secure each door.
 - .3 Identify each door control function with lamp electronically identified on panel or associated display unit.
 - .4 Permanently label (paper labels are not acceptable) or electronically identified each door location on panel or associated display unit.
 - .5 Fully function within supplied electrical supervision circuits as specified.
- .12 Control Signal Standards:
 - .1 Input and Output Signal: 0.0 dBmV + 1.0 dBmV Level.
 - .2 Input and Output Signals: terminated on each control unit.
 - .3 Input and Output Impedance: 120 Ohms, BAL.
 - .4 Channel Bandwidth:
 - .1 Data: 300 Hz to 3.5 kHz (9.6 kilo bits per second rate).
 - .2 DC: 0.5 Hz to 100 Hz, + 5.0%, MIN.

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- .5 S/N Ratio: 60 dBmV + 1.0 dBmV.
 - .2 Door controls items and panels:
 - .1 Include standard "off the shelf" equipment items to form a complete and operating DRS system.
 - .2 Include: equipment cabinets, equipment panels, AC power strips, power line conditioner, system power supply, junction box, door control panels, door activation units, electronic supervising master panel, electronic supervising remote panel s, system connectors, and system cables.
 - .3 Provide system cables including coaxial cable, multiconductor control cable, audio and AC power cable required.
 - .4 Power supplies: to CAN/ULC-S318.
 - .5 Connectors and switches: to ULC-C634.
 - .6 Basic System Criteria:
 - .1 Card readers:
 - .1 Type: proximity.
 - .2 Quantity of card readers required: as shown on plans
 - .3 Proximity technology.
 - .4 Fitted with LED indicator light.
 - .5 Reading distance 50 - 200 mm.
 - .6 Compatible with access card model.
 - .7 Personal Identification Number (PIN) number access: 4 user codes.
 - .2 Keypads:
 - .1 Quantity of keypads required: as shown on plans
 - .2 Fitted with LED indicator light.
 - .3 Combination card readers and keypad:
 - .1 Quantity of units required: as shown on plans
 - .2 Proximity technology.
 - .3 Fitted with LED indicator light.
 - .4 Reading range: 50 mm (2") 75 mm (3").
 - .5 Compatible with access card model.
 - .4 Cards: key tag, plastic, credit-card size, sealed and highly resistant to normal handling and weather, fitted with vertical slot punched hole.
 - .1 Quantity of cards required: 100
 - .2 Guaranteed for 5 years against all defects and protected against:
 - .1 Magnetic encoded cards.
 - .2 Metal objects including coins and keys.
 - .3 Retail shoplifting detection equipment.
 - .4 Communication equipment.
 - .3 Coding:
 - .1 Designed with highly secure codification of card information.
 - .2 Card life: minimum period of 10 years for cards in same family.
 - .3 Use 1 series of cards for all areas protected by access control system.
 - .5 Quantity of alarm monitoring points required: as shown on plans.
 - .6 Quantity of outputs required.

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- .7 Number of access levels (assigned to cardholders): .
 - .8 Schedules:
 - .1 Number of date schedules required: 100.
 - .2 Number of holiday schedules required: 180.
 - .3 Allow full schedule description label of 30 alphanumeric characters.
 - .4 Include 4-time intervals/day.
 - .9 Groups:
 - .1 Design system to include possibility of group association in following categories:
 - .1 Controller groups : 100.
 - .2 Door groups: 100.
 - .3 Relay groups: 100.
 - .4 Input groups: 100.
 - .5 Access groups: 100.
 - .2 Design groups with fully customizable field of 30 alphanumeric characters for easy renaming of associated group.
 - .10 Operating system: Windows 10.
 - .11 Connection: local.
 - .12 Language: English.
 - .13 Off site monitoring of alarm conditions.
 - .8 System Accessories:
 - .1 Door strike: latch, UL approved complete with mounting hardware.
 - .2 Magnetic lock: holding force 1200 lbs, UL approved complete with mounting hardware.
 - .3 Request to exit motion detector device:
 - .1 Infrared detection.
 - .2 Continuous low-voltage operation.
 - .3 Fitted with indicator light.
 - .4 Integrated with local audio alarm (electronic buzzer).
 - .5 Adjustable coverage.
 - .4 Request to exit motion push button device:
 - .1 Heavy duty assembly.
 - .2 Size: square, 50 x 50 mm.
 - .3 Sturdy and attractive finishing plate with security screws.
 - .5 Pull station power interrupt.
 - .6 Power supplies:
 - .1 Continuous low-voltage operation output.
 - .2 Equipped with secondary protection for each output.
 - .3 Individual outputs for connection of devices.
 - .4 AC power failure output.
 - .5 DC power failure output and low battery output.
 - .6 Fitted with tamper contact.
 - .7 Wall mounted cabinet with locked door complete with 2 keys.
 - .7 Voltage: 24 volt DC.

3 EXECUTION

3.01 INSTALLATION: SECURITY ACCESS

- .1 Install security access systems and components in accordance with CAN/ULC- S302 CAN/ULC-S310.
- .2 Install components in accordance with manufacturer's written installation instructions to locations, heights and surfaces shown on reviewed shop drawings.
- .3 Install components secure to walls, ceilings or other substrates.
- .4 Install required boxes in inconspicuous accessible locations.
- .5 Conceal conduit and wiring.

3.02 SITE TEST AND INSPECTION

- .1 Perform verification inspections and test in presence of Consultant.
 - .1 Provide all necessary tools, ladders and equipment.
 - .2 Ensure appropriate subcontractors, and manufacturer's representatives and security specialists are present for verification.
- .2 Pretesting procedure:
 - .1 Verify (utilizing an approved spectrum analyzer and test equipment) that system is fully operational and meets all system performance requirements of this specification.
 - .2 Measure and record, control (and/or voice) carrier levels of every system channel at each of following points in the system:
 - .1 Door located actuating devices.
 - .2 Door control panel functions.
 - .3 Electronic supervisory control units inputs and outputs.
 - .4 Distribution system input and output.
 - .5 Telephone system interface input and output.
- .3 Performance testing:
 - .1 Test procedure: perform test on a "go-no-go" basis.
 - .1 Make only operator adjustments required to show proof of performance.
 - .2 Test to demonstrate and verify that installed system complies with installation and technical requirements of this specification under operating conditions.
 - .3 Test results to be evaluated by Consultant as either acceptable or unacceptable using following procedures.
 - .2 Documentation review:
 - .1 This review will determine if information provided is sufficient to meet requirements of this specification.
 - .2 Provide for review all System manuals, as installed drawings, pretest forms, antenna radiation patterns, equipment cabinet pictorials, antenna pictorial, antenna mount pictorial, video and audio equipment details.
 - .3 Mechanical inspection:
 - .1 Consultant and Contractor to tour areas to ensure that Systems and Subsystems are installed in place for proof of performance testing.

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- .2 Take system inventory at this time. Verify following items before beginning proof of performance tests:
 - .1 Electrical power circuits designated for system equipment are properly labeled, wired, phased, protected and grounded.
 - .2 Conductor ends are protected by heat shrink wrap; audio spade lugs, barrier strips and punch blocks are used.
 - .3 Dust, debris, solder splatter, etc. are cleaned and removed from site.
 - .4 Equipment is properly labelled.
 - .5 Equipment identified in system's equipment lists are in- place and properly installed.
 - .6 Each lightning and System ground method are installed in accordance with manufacturer's instructions and this specification.
 - .4 Subsystem functional test:
 - .1 Conduct operational testing after review of documentation and mechanical inspection completed. Proceed as follows.
 - .1 Perform operational test of each Subsystem to verify that all equipment is properly connected, interfaced and is functionally operational to meet requirements of this specification.
 - .2 Control units:
 - .1 Take S/N readings from control unit's input and output in manual (and/or automatic) mode. Check output of DC/Data converter for S/N. Evaluate entire signal quality at baseband connector output of control unit and remote equipment.
 - .3 Audio:
 - .1 Take S/N readings from transmitter input and receiver output with equipment placed in manual gain mode. Check output of the audio converter, modulator or demodulator for S/N. Evaluate entire audio signal at baseband connector input and output of control unit.
 - .4 Distribution (or interface) system:
 - .1 Check each door utilizing a volt/ohm (or signal level) meter to confirm each function and to ensure that system meets all performance requirements.
 - .2 Test each interconnection point (i.e.: door unit, junction box "cross connection", control unit, etc.) to ensure compliance with this specification.
 - .5 Total system test:
 - .1 Proceed with testing when system and subsystems are functionally tested and accepted. Total system tests to verify that requirements have been met for DC (and/or audio), sub carrier, and control signals in accordance with this specification.
 - .6 Safety:
 - .1 Demonstrate with documentation that access control system meets safety requirements specified in UL 294.
 - .5 Visual verification: objective is to assess quality of installation and assembly and overall appearance to ensure compliance with Contract Documents. Visual inspection to include:
 - .1 Sturdiness of equipment fastening.
 - .2 Non-existence of installation related damages.
 - .3 Compliance of device locations with reviewed shop drawings.
 - .4 Compatibility of equipment installation with physical environment.
 - .5 Inclusion of all accessories.

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- .6 Device and cabling identification.
 - .7 Application and location of ULC approval decals.
 - .6 Technical verification: purpose to ensure that all systems and devices are properly installed and free of defects and damage. Technical verification includes:
 - .1 Validate sensitivity of readers and applicability and application of cards.
 - .2 Connecting joints and equipment fastening.
 - .3 Compliance with manufacturer's specification, product literature and installation instructions.
 - .7 Operational verification: purpose to ensure that devices and systems' performance meet or exceed established functional requirements. Operational verification includes:
 - .1 Operation of each device individually and within its environment.
 - .2 Operation of each device in relation with programmable schedule and or/specific functions.

3.03 FIELD QUALITY CONTROL

- .1 Manufacturer Services:
 - .1 Manufacturer of products, supplied under this Section, to review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Manufacturer's Field Services:
 - .1 Obtain written reports from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.
 - .2 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Ensure manufacturer's representative is present before and during critical periods of installation and testing.
 - .4 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
 - .3 Clean components free from dirt and fingerprints.

3.04 PROTECTION

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

END OF SECTION

FIRE DETECTION AND ALARM SYSTEM

3180 POINT INTELLIGENT FIRE ALARM DETECTION SYSTEM

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Fire Suppression.

1.2 DESCRIPTION:

- A. This section of the specification includes the furnishing, installation, and connection of an intelligent reporting, microprocessor controlled, addressable, fire detection and emergency voice alarm communication system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.
- B. The fire alarm system shall comply with requirements of CAN/ULC Standards. The system shall be electrically supervised and monitor the integrity of all conductors.
- C. The system shall be an active/interrogative type system where each addressable device is repetitively scanned, causing a signal to be transmitted to the main fire alarm control panel (FACP) indicating that the device and its associated circuit wiring is functional. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.
- D. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.
- E. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
- F. The system and its components shall be Underwriters Laboratories of Canada listed under the appropriate ULC testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the CAN/ULC-S524-06 Standard.
- G. The installing company shall employ qualified Fire Alarm Technicians on site to guide the final checkout and to ensure the systems integrity.
- H. Fire Alarm System shall be tested as an integrated system as per CAN/ULC-S1001.

1.3 SCOPE:

- A. A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance with the specifications and drawings.
- B. The system shall be designed such that each Data Communication Link (DCL) is limited to only 80% of its total capacity at initial installation.
- C. Basic Performance:
 - 1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on Class A Data Communication Link (DCLA).
 - 2. Initiation Device Circuits (IDC) shall support Class A or Class B wiring as part of an addressable device connected by the DCLA Circuit
 - 3. Notification Appliance Circuits (NAC) shall support Class A or Class B wiring as part of an addressable device connected by the DCL Circuit.
 - 4. On Class A configurations a single ground fault or open circuit on the system Signalling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
 - 5. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
- D. Basic System Functional Operation

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

- 1. The System Alarm LED shall flash.
- 2. A local piezo electric signal in the control panel shall sound.
- 3. The 640 character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
- 4. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
- 5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

1.4 SUBMITTALS

A. General:

1. At least two copies of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible ULC listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
3. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show annunciator layout, configurations, and terminations.

C. Manuals:

1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.
4. Approvals will be based on complete submissions of manuals together with shop drawings.

D. Software Modifications

1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications onsite. Modification of

software shall not require power down of the system or loss of system fire protection while modifications are being made.

E. Certifications:

Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

1.5 GUARANTY:

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least 12 months from the date of acceptance. The full cost of maintenance, labour and materials required to correct any defect during this one year period shall be included in the submittal bid.

1.6 POST CONTRACT MAINTENANCE:

- A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.
- B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.
- C. Maintenance and testing shall be on an annual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:
 - 1. Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.
 - 2. Each circuit in the fire alarm system shall be tested annually.
 - 3. Each smoke detector shall be tested in accordance with the requirements of CAN/ULC S-536.

1.7 POST CONTRACT EXPANSIONS:

- A. The contractor shall have the ability to provide parts and labour to expand the system specified, if so requested, for a period of five (5) years from the date of acceptance.
- B. As part of the submittal, include a quotation for all parts and material, and all installation and test labour as needed to increase the number of intelligent or addressable devices by ten percent (10%). This quotation shall

include intelligent smoke detectors, intelligent heat detectors, addressable manual stations, addressable monitor modules and addressable modules equal in number to one tenth of the number required to meet this specification (list actual quantity of each type).

- C. The quotation shall include installation, test labour, and labour to reprogram the system for this 10% expansion. If additional FACP hardware is required, include the material and labour necessary to install this hardware.
- D. Do not include cost of conduit or wire or the cost to install conduit or wire.
- E. Submittals that do not include this estimate of post contract expansion cost will not be accepted.

1.8 APPLICABLE PUBLICATIONS:

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

- A. Government of Canada:
 - Canadian Building Code as adopted by the Provincial Building Code
 - The Canadian Electrical Code, Part 1
- B. Underwriters Laboratories of Canada (ULC):
 - CAN/ULC-S524, Installation of Fire Alarm Systems.
 - CAN/ULC-S525, Audible Signal Appliances for Fire Alarm.
 - CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.
 - CAN/ULC-S527, Control Units.
 - CAN/ULC-S528, Manual Pull Stations.
 - CAN/ULC-S529, Smoke Detectors.
 - CAN/ULC-S530, Heat Actuated Fire Detectors.
 - CAN/ULC-S531, Smoke Alarms.
 - CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems.
 - CAN/ULC-S537, Verification of Fire Alarm Systems.

C. National Fire Protection Association (NFPA):

No. 12 CO2 Extinguishing Systems (low and high)

No. 12B Halon 1211 Extinguishing Systems

No. 13 Sprinkler Systems

No. 13A Halon 1301 Extinguishing Systems

No. 15 Water Spray Systems

No. 16 Foam/Water Deluge and Spray Systems

No. 17 Dry Chemical Extinguishing Systems

No. 17A Wet Chemical Extinguishing Systems

No. 72 National Fire Alarm Code

No. 101 Life Safety Code

No. 2001 Clean Agent Fire Extinguishing Systems

D. Local and Provincial Building Codes.

E. All requirements of the Authority Having Jurisdiction (AHJ).

1.9 APPROVALS:

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

ULC Underwriters Laboratories Canada.

B. The Fire Alarm Control Panel and all transponders shall meet the modular listing requirements of Underwriters Laboratories of Canada. Each subassembly, including all printed circuits, shall include the appropriate ULC modular label. This includes all printed circuit board assemblies, power supplies, and enclosure parts. Systems that do not include modular labels may require return to the factory for system upgrades, and are not acceptable.

C. The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of high and low pressure CO2.

PART 2.0 PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL:

- A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signalling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.
- B. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
- D. All equipment shall be supplied by Notifiers Authorizes Engineered Systems

Distributor CONTROL FIRE SYSTEMS LTD (i.e. 416-236-2371) which is the

Authorized Engineered Systems representative for this project.

2.2 CONDUIT AND WIRE:

A. Conduit:

- 1. Conduit shall be in accordance with Canadian Electrical Code as adopted by the local Province
- 2. Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
- 3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors.
- 4. Wiring for 24 volt control, alarm notification, emergency communication and similar power limited auxiliary functions may be run in the same conduit as initiating and signalling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
- 5. Conduit shall not enter the fire alarm control panel or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer.

B. Wire

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1. All fire alarm system wiring must be new.
 2. Wiring shall be in accordance with local, provincial and national codes and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits and signalling line circuits, and 14 AWG (1.63 mm) for notification appliance circuits.
 3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system.
 4. Wiring used for the multiplex communication circuit (DCL) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the DCL communication circuit.
 5. The system shall permit the use of IDC and NAC wiring in the same conduit with the multiplex communication loop.
 6. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; A trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

C. Terminal Boxes, Junction Boxes and Cabinets:

All boxes and cabinets shall be CSA listed for their intended purpose.

- D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on Data Communication Link connected to intelligent reporting devices.
- E. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labelled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

2.3 MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:

- A. The main FACP Central Console shall be a NOTIFIER Model NFS2-3030 or approved equivalent by CONTROL FIRE SYSTEMS and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.
- B. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:
 1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
 2. Supervise all initiating signalling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.

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3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all DCL loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding DCL loop control modules and associated detection devices as conventional two wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.
 4. Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.
 5. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
 - a. The system alarm LED shall flash.
 - b. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
 - c. The 640 character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
 - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
 - e. All system outputs assigned via pre-programmed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
 - f. When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
 - g. The system trouble LED shall flash.
 - h. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
 - i. The 640character backlit LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.
 - j. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
 - k. All system outputs assigned via pre-programmed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.
 6. When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
 - a. The system trouble LED shall flash.

-
- b. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
 - c. The 640 character backlit LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.
 - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
 - e. All system outputs assigned via pre-programmed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.
7. When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
- a. The system security LED shall flash.
 - b. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
 - c. The 640 character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
 - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
 - e. All system outputs assigned via pre-programmed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
8. When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
- a. The system pre-alarm LED shall flash.
 - b. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
 - c. The 640character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
 - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

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- e. All system outputs assigned via pre-programmed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

C. Operator Control

1. Acknowledge Switch:

- a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.
- b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

2. Signal Silence Switch:

- a. Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto silence timers.

3. Drill Switch:

- a. Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

4. System Reset Switch:

- a. Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall report if active. Active notification appliance circuits shall not silence upon Reset. Systems that deactivate and subsequently reactivate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re report upon reset.

5. Lamp Test:

- a. The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

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6. Scroll Display Keys:
 - a. There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.
 7. Print Screen:
 - a. Depression of the PRINT SCREEN switch shall send the information currently displayed on the 640character display to the printer.

D. System Capacity and General Operation

1. The control panel shall be capable of expansion via up to 10 DCL modules. Each module shall support a maximum of 318 analogue/addressable devices for a maximum system capacity of 3,180 points. The system shall be capable of 3072 annunciation points per system regardless of the number of addressable devices.
2. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640 character liquid crystal display, individual, colour coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company.
3. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
4. The FACP or each node shall be able to provide the following software and hardware features:
 - a. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15 second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.
 - b. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
 - c. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
 - d. Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre Alarm level, with general evacuation on Alarm level.

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- e. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
 - f. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
 - g. Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the requirements of CAN/ULC-S527.
 - h. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
 - i. Online or Offline programming: The system shall provide means to allow panel programming either through an offline software utility program away from the panel or while connected and online. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.
 - j. History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.
 - k. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet CAN/ULC-S527 and the National Building Code of Canada and HVAC mode to meet the National Building Code of Canada.
 - l. The system shall provide means for all DCL devices on any DCL loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
 - m. Drill: The system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function.
 - n. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
 - o. Two Wire Detection: The system shall support standard two wire detection devices specifically all models of System Sensor devices, Fenwal PDS7125/ 7126 and CPD7021, Hochiki model SLK24F/ 24FH, Edwards 6250B/6270B and 6264B and Simplex models 20989201/ 9202 and 9576 or approved equivalent.
 - p. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions

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- q. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.
 - r. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.
 - s. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
 - t. Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, pre-alarms, disabled points and activated points, all installed points filtered by DCL points, logic zones, annunciators, releasing zones, special zones, and trouble zones.
 - u. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the DCL and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.
 - v. Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will Re-sound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will Re-sound the panel sounder.
 - w. Read status preview enabled and disabled points: Prior to re enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.
 - x. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bitmapped graphic to the display screen.

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- y. Multi Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.
 - z. Tracking/Latching Duct (ion and photo): The system shall support both tracking and latching duct detectors either ion or photo types.
 - aa. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control by Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.
 - bb. NONFIRE Alarm Module Reporting: A point with a type ID of NONFIRE shall be available for use for energy management or other non fire situations. NONFIRE point operation shall not affect control panel operation nor shall it display a message at the panel LCD. Activation of a NONFIRE point shall activate control by event logic but shall not cause any indication on the control panel.
 - cc. Security Monitor Points: The system shall provide means to monitor any point as a type security.
 - dd. One Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.
 - ee. Control-By-Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.
 - ff. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non Alarm or Supervisory points shall not activate the general alarm zone.

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- gg. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.
 - hh. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.
 - ii. 10 trouble equations per device: The system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.
 - jj. Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.
 - kk. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross zone and four abort options to satisfy any local jurisdiction requirements.
 - ll. Alarm Verification, by device, with timer and tally: The system shall provide a user defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

E. Central Processing Unit

1. The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.
2. The Central Processing Unit shall contain and execute all control by event (including Boolean functions including but not limited to AND, OR, NOT, ANY, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control by event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

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3. The Central Processing Unit shall also provide a real time clock for time annotation, to the second, of all system events. The time of day and date shall not be lost if system primary and secondary power supplies fail.
 4. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
 5. Consistent with UL864 standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.
 6. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.
 7. The CPU shall provide an EIA232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
 8. The CPU shall provide two EIA485 ports for the serial connection to annunciation and control subsystem components.
 9. The EIA232 serial output circuit shall be optically isolated to assure protection from earth ground.
 10. The CPU shall provide one high speed serial connection for support of network communication modules.
 11. The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.

F. Display

1. The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
3. The system display shall provide a 640character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide ten Light Emitting Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.

4. The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
5. The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 640character LCD.

G. Loop (Signalling Line Circuit) Control Module:

1. The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Ionization, Photoelectric, or Thermal) and 159 monitor or control modules.
2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
3. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This DCL Loop shall be capable of operating as a Class B circuit.
4. The DCL interface board shall be able to drive a Class A or B twisted unshielded circuit up to 12,500 feet in length. The DCL Interface shall also be capable of driving a Class A or B, no twist, no shield circuit for limited distances determined by the manufacturer. In addition, DCL wiring shall meet the listing requirements for it to exit the building or structure. "T" tapping shall be allowed in either case.
5. The DCL interface board shall receive analogue or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each DCL Loop shall be isolated and equipped to annunciate an Earth Fault condition. The DCL interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analogue information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

H. Enclosures:

1. The control panel shall be housed in a ULC listed cabinet suitable for surface or semi flush mounting. The cabinet and front shall be corrosion protected, given a rust resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.

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3. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left hand side.
 4. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

I. Power Supply:

1. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
2. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual rate charging techniques for fast battery recharge.
3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25 - 200 amp hours within a 48 hour period.
4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
5. The Addressable Main Power Supply shall be power limited.

K. System Circuit Supervision

1. The FACP shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communication with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information in the history buffer and on the printer.
2. Transponders that lose communication with the CPU shall sound an audible trouble and light an LED indicating loss of communications.
3. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off normal position.

L. Field Wiring Terminal Blocks

1. All wiring terminal blocks shall be the plug in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

M. Remote Transmissions:

1. Provide local energy or polarity reversal or trip circuits as required.

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2. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.
 3. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.
 4. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

N. System Expansion:

Design the main FACP and required components so that the system can be expanded in the future (to include the addition of twenty percent more circuits or zones) without disruption or replacement of the existing control panel. This shall include hardware capacity, software capacity and cabinet space.

O. Field Programming

1. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
2. It shall be possible to program through the standard FACP keyboard all system functions.
3. All field defined programs shall be stored in non-volatile memory.
4. Two levels of password protection shall be provided in addition to a key lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.
5. The system programming shall be "backed" up via an upload/download program, and stored on compatible removable media. A system backup disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.
6. The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input to Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.

P. Specific System Operations

1. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analogue intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed ULC window.
2. Alarm Verification: Each of the Intelligent Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or anytime after system turn on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

Q. System Point Operations:

1. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
2. System output points shall be capable of being turned on or off from the system keypad or the video terminal.
3. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
 - a. Device Status.
 - b. Device Type.
 - c. Custom Device Label.
 - d. Software Zone Label.
 - e. Device Zone Assignments.
 - f. Analog Detector Sensitivity.
 - g. All Program Parameters.
4. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses:
5. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.
6. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.
7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
8. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated

on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

9. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

2.4 SYSTEM COMPONENTS:

A. Programmable Electronic Sounders:

1. Shall be a System Sensor SpectrAlert Advance which is listed to CAN/ULC-S525, Audible Signal Appliances, Fire Alarm.
2. Shall operate on 24 VDC nominal.
3. Shall be field programmable with three audibility options and an option to switch between a temporal three-pattern and a non-temporal (continuous) pattern without the use of special tools.
4. Shall produce a sound level of at least 90 dBA measured at 10 feet from the device.
5. Shall be flush or surface mounted as shown on plans.

B. Strobe lights shall meet the requirements of CAN/ULC-524, Installation of Fire Alarm, and be fully synchronized, and shall meet the following criteria:

1. Shall be a System Sensor SpectrAlert Advance which consists of a xenon flash tube and associated lens/reflector system, is listed to CAN/ULC-S526 and shall be approved for fire protective service.
2. Strobe intensity shall meet the requirements of CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.
3. The flash rate shall meet the requirements of CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.
4. Shall have field-selectable candela settings including 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, 185.

C. Manual Fire Alarm Stations

1. Manual fire alarm stations shall be non-coded, non-breakglass type, equipped with key lock so that they may be tested without operating the handle.
2. Stations must be designed such that after an actual activation, they cannot be restored to normal except by key reset.
3. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 100 feet (30.5 m) front or side.
4. Manual stations shall be constructed of high impact Lexan, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters one half inch (12.7 mm) in size or larger.

D. Conventional Photoelectric Area Smoke Detectors

1. Photoelectric smoke detectors shall be a 24 VDC, two-wire, ceiling mounted, light scattering type using an LED light source.
2. Each detector shall contain a remote LED output and a built in test switch. 3. Detector shall be provided on a twist lock base.
4. It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.
5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360 degrees. These LEDs shall flash at least every 10 seconds, indicating that power is applied to the detector.
6. The detector shall not go into alarm when exposed to air velocities of up to 3000 feet (914.4 m) per minute.
7. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
8. All field wire connections shall be made to the base through the use of a clamping plate and screw.

E. Conventional Ionization Type Area Smoke Detectors

1. Ionization type smoke detectors shall be a two wire, 24 VDC type using a dual uni-polar chamber.
2. Each detector shall contain a remote LED output and a built in test switch. 3. Detector shall be provided on a twist lock base.
4. It shall be possible to perform a calibration sensitivity and performance test on the detector without the need for the generation of smoke.
5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs) over 360 degrees, on the detector, which may be seen from ground level. This LED shall flash every 10 seconds, indicating that power is applied to the detector.
6. The detector shall not alarm when exposed to air velocities of up to 1,200 feet (365.76 m) per minute. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
7. All field wire connections shall be made to the base through the use of a clamping plate and screw.

F. Duct Smoke Detectors

1. Duct smoke detectors shall be a 24 VDC type with visual alarm and power indicators, and a reset switch.
2. Each detector shall be installed upon the composite supply air ducts(s), with properly sized air sampling tubes.

G. Projected Beam Detectors

1. The projected beam type shall be a 24 VDC device.
2. The detector shall be ULC listed and shall consist of a separate transmitter and receiver capable of being powered separately or together.
3. The detector shall operate in either a short range (30' - 100') or long range (100' - 330') mode.
4. The temperature range of the device shall be 22 degrees F (-5.5 Celsius) to 131 degrees F (55 Celsius).
5. The detector shall feature a bank of four alignment LEDs on both the receiver and the transmitter that are used to ensure proper alignment of unit without special tools.
6. Beam detectors shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on lenses.
7. The unit shall be both ceiling and wall mountable.
8. The detector shall have the ability to be tested using calibrated test filters or magnet activated remote test station.

H. Automatic Conventional Heat Detectors

1. Automatic heat detectors shall have a combination rate of rise and fixed temperature rated at 135 degrees Fahrenheit (57.2 Celsius) for areas where ambient temperatures do not exceed 100 degrees (37.7 Celsius), and 200 degrees (93.33 Celsius) for areas where the temperature does not exceed 150 degrees (65.5 Celsius).
2. Automatic heat detectors shall be a low profile, ceiling mount type with positive indication of activation.
3. The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 degrees F (9.4 degrees C) per minute.
4. The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
5. Automatic heat detectors shall have a smooth ceiling rating of 900 square feet (87 meters square).

I. Waterflow Indicator:

1. Waterflow Switches shall be an integral, mechanical, non coded, non accumulative retard type.
2. Waterflow Switches shall have an alarm transmission delay time which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30 - 45 seconds.
3. All waterflow switches shall come from a single manufacturer and series.

4. Waterflow switches shall be provided and connected under this section but installed by the mechanical contractor.
5. Where possible, locate waterflow switches a minimum of one (1) foot from a fitting which changes the direction of the flow and a minimum of three (3) feet from a valve.

J. Sprinkler and Standpipe Valve Supervisory Switches:

1. Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.
3. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one fifth of the distance from its normal position.
4. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4 inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The switch housing shall be finished in red baked enamel.
6. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.
7. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.
 - a. This unit shall provide for each zone: alarm indications, using a red alarm a yellow trouble long-life LEDs and control switches for the control of fire alarm control panel functions. The annunciator will also have an ONLINE LED, local piezo electric signal, local acknowledge/lamp test switch and custom slide in zone/function identification labels.
 - b. Switches shall be available for remote annunciation and control of output points in the system, system acknowledge, global signal silence, and global system reset within the confines of all applicable standards.

2.5. SYSTEM COMPONENTS ADDRESSABLE DEVICES

A. Addressable Devices General

1. Addressable devices shall provide an address setting means using rotary decimal switches.

2. Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches. Devices which use a binary address or special tools for setting the device address, such as a dip switch are not an allowable substitute.
3. Detectors shall be Analogue and Addressable, and shall connect to the fire alarm control panel's Signalling Line Circuits.
4. Addressable smoke and thermal detectors shall provide dual (2) status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs can be programmed off via the fire control panel program.
5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time of day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by ULC as meeting the calibrated sensitivity test requirements of CAN/ULC-S529 Smoke Detector.
7. The detectors shall be ceiling mount and shall include a separate twist lock base which includes a tamper proof feature.
8. The following bases and auxiliary functions shall be available:
 - a. Sounder base rated at 85 dBA minimum.
 - b. Form C Relay base rated 30VDC, 2.0A
 - c. Isolator base
9. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
10. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (example: ION, PHOTO, THERMAL).

B. Addressable Manual Fire Alarm Box (manual station)

1. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

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3. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

C. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analogue level of smoke density.

D. Intelligent Laser Photo Smoke Detector

1. The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.
2. The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.
3. The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.
4. The laser detector shall not require expensive conduit, special fittings or PVC pipe.
5. The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
6. The laser photo detector shall not require other cleaning requirements than those listed in CAN/ULC-S529 Smoke Detector. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
7. The laser photo detector shall include two bi-colour LEDs that flash green in normal operation and turn on steady red in alarm.

E. Intelligent Ionization Smoke Detector

1. The detectors shall use the dual chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analogue level of products of combustion.

F. Intelligent Multi Criteria Acclimating Detector

1. The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built in microprocessor to determine its environment and choose the appropriate sensing settings.
The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smouldering fires and thermal properties all within a single sensing device.

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2. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
 3. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

G. Intelligent Thermal Detectors

1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate of rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signalling line circuit.

H. Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analogue monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

I. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel DCLs.
2. The IDC zone shall be suitable for Class A or B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 23/ 4 inch (70 mm) x 11/ 4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include an LED.

J. Two Wire Detector Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2wire smoke detectors or alarm initiating devices (any N.O. dry contact device).

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2. The IDC zone may be wired for Class A or B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

K. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered polarized audio/visual notification appliances.
2. The control module NAC may be wired for Class A or B with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.
3. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised ULC listed remote power supply.
4. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

L. Addressable Relay Module

1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

M. Addressable 4-20mA Monitor Module

1. Addressable 4-20mA monitor modules shall be available to connect supervised industry-standard, linear-scale, 4–20 mA protocol sensors.
2. Addressable 4-20mA monitor modules shall support up to five programmable thresholds and a 500 mA current limiter and a cut-off circuit protecting the module's electrical supply from short circuits.
3. Addressable 4-20mA monitor modules shall accept both 3-wire (device sink) and 2-wire configurations.
4. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

N. Isolator Module

1. Isolator modules shall be provided to automatically isolate wire to wire short circuits on a DCL Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the DCL loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire to wire short occurs, the isolator module shall automatically open circuit (disconnect) the DCL. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

3. The isolator module shall not require address setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

O. Projected Beam Detectors

1. The detector shall consist of a separate transmitter and receiver capable of being powered separately or together.
2. The detector shall operate in either a short range (30' - 100') or long range (100' - 330') mode.
3. The temperature range of the device shall be 22 degrees F (-5.5 Celsius) to 131 degrees F (55 Celsius).
4. The detector shall feature a bank of four alignment LEDs on both the receiver and the transmitter that are used to ensure proper alignment of unit without special tools.
5. Beam detectors shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on lenses.
6. The unit shall be both ceiling and wall mountable.
7. The detector shall have the ability to be tested using calibrated test filters or magnet activated remote test station.

P. Smoke Control Annunciator

1. On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the National Building Code of Canada, and CAN/ULC-S527.
2. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFFNORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
3. Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.
4. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC contractor.
5. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.

Q. Serially Connected Annunciator Requirements

1. The annunciator shall communicate to the fire alarm control panel via an EIA 485 (multi drop) two wire communications loop. The system shall support two 6,000 ft. EIA485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,072 points of annunciation.
2. An EIA485 repeater shall be available to extend the EIA485 wire distance in 3,000 ft. increments. An optional version shall allow the EIA485 circuit to be transmitted over fibre optics. The repeater shall be ULC listed.
3. Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long life programmable colour LED's. Up to 96 control switches shall also be available for the control of Fire Alarm Control Panel functions. The annunciator will also have an "ONLINE" LED, local piezo sounder, local acknowledge and lamp test switch, and custom zone/function identification labels.
4. The annunciator may be field configured to operate as a "Fan Control Annunciator". When configured as "Fan Control," the annunciator may be used to manually control fan or damper operation and can be set to override automatic commands to all fans/dampers programmed to the annunciator.
5. Annunciator switches may be programmed for System control such as, Global Acknowledge, Global Signal Silence, Global System Reset, and on/off control of any control point in the system.
6. An optional module shall be available to utilize annunciator points to drive EIA485 driven relays. This shall extend the system point capacity by 3,072 remote contacts.
7. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

2.6 BATTERIES AND EXTERNAL CHARGER:

A. Battery:

1. Shall be 12 volt, Gel Cell type.
2. Battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.
3. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.

B. External Battery Charger:

1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240volt 50/60 hertz source.

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2. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.
 3. Shall have protection to prevent discharge through the charger.
 4. Shall have protection for overloads and short circuits on both AC and DC sides.

PART 3.0 EXECUTION

3.1. INSTALLATION:

- A. Installation shall be in accordance with the CAN/ULC S-524 Installation of Fire Alarm standard, local and provincial codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- D. Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 1200mm, nor more than 1400mm above the finished floor.

3.4. TYPICAL OPERATION:

- A. Actuation of any manual station, smoke detector heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:
 1. Activate all programmed NAC circuits.
 2. Actuate all strobe units until the panel is reset.
 3. Release all magnetic door holders to doors to adjacent zones on the floor from that the alarm was initiated.
 4. Return all elevators to the primary or alternate floor of egress.
 5. A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.
 6. Smoke detectors in the elevator machine room or top of hoist way shall return all elevators in to the primary or alternate floor.
 7. Duct type smoke detectors shall, in addition to the above functions shut down the ventilation system or close associated control dampers as appropriate.

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8. Activation of any sprinkler system low pressure switch or valve tamper switch shall cause a system supervisory alarm indication.

3.5. TEST:

- A. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with CAN/ULC S537.
- B. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- C. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
- D. Verify activation of all flow switches.
- E. Open initiating device circuits and verify that the trouble signal actuates.
- F. Open Data Communication Link and verify that the trouble signal actuates.
- G. Open and short notification appliance circuits and verify that trouble signal actuates.
- H. Ground initiating device circuits and verify response of trouble signals.
- I. Ground Data Communication Link and verify response of trouble signals.
- J. Ground notification appliance circuits and verify response of trouble signals.
- K. Check presence and audibility of tone at all alarm notification devices.
- L. Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.
- M. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- N. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.6 FINAL INSPECTION:

- A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.7 INSTRUCTION:

- A. Provide instruction as required for operating the system. Hands on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
- B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

END OF SECTION

SECTION 6.2 PORTABLE EXTINGUISHERS

Subsection 6.2.1. General

6.2.1.1. Listed portable extinguishers shall be installed when adding new extinguishers.

Maintenance

6.2.1.2. Portable extinguishers shall be kept operable and fully charged.

Location

6.2.1.3. (1) Portable extinguishers shall be located so that they are easily seen and shall be accessible at all times, except as permitted in Sentences (2) and (3).

(2) A lockable, break-front glazed cabinet may be used for security purposes to store portable extinguishers and where portable extinguishers are located in a fire hose cabinet, an approved lockable, scored glass break-front cabinet may be used.

6.2.1.4. Portable extinguishers shall be located in or adjacent to corridors or aisles that provide access to exits.

Signs

6.2.1.5. The location of portable extinguishers shall be prominently indicated by signs or markings in large floor areas and in locations where visual obstructions cannot be avoided.

Proximity to Fire Hazards

6.2.1.6. Portable extinguishers in proximity to a fire hazard shall be located so as to be accessible without exposing the operator to undue risk.

Corrosive Atmosphere

6.2.1.7. Portable extinguishers that are subject to corrosion shall not be installed in a corrosive environment unless they are provided with appropriate corrosion protection.

Temperature Range Requirements

6.2.1.8. (1) Where a portable extinguisher is to be located in an area subject to temperatures outside the range 4°C to 49°C, it shall be

- (a) placed in an enclosure where the temperature is maintained within this range, or
- (b) of a type labelled for the temperatures to which it will be exposed.

Mounting Brackets

6.2.1.9. When portable extinguishers are located on vehicles or in areas where they are subject to jarring or vibration, brackets designed to accommodate these effects shall be used.

Subsection 6.2.2. Classification

Rating of Portable Extinguishers

6.2.2.1. Portable extinguishers shall be rated and identified in conformance with CAN/ULC-S508, "Standard for the Rating and Fire Testing of Fire Extinguishers".

Subsection 6.2.3. Selection Requirements

Multiple Ratings

6.2.3.1. Where portable extinguishers have been tested and are rated as being acceptable for fighting more than one class fire, each class of fire for which they are acceptable shall be designated on each extinguisher.

Subsection 6.2.4. Installation Requirements

Distance Above Floor

6.2.4.1. Portable extinguishers with a gross weight greater than 18 kg shall be installed so that the top of the extinguisher is not more than 1.1 m above the floor when the extinguisher is not equipped with wheels.

6.2.4.2. Portable extinguishers having a gross weight of 18 kg or less shall be installed so that the top of the extinguisher is not more than 1.5 m above the floor.

Operating Instructions

6.2.4.3. The operating instructions of portable extinguishers shall face outward when the extinguishers are located in cabinets, in wall recesses or on shelves.

Subsection 6.2.5. Grading of Hazards

Light Hazard Occupancy

6.2.5.1. Where the quantity of combustible material present is such that fires of small size may be expected, such as in offices, schoolrooms, churches, assembly halls and telephone exchanges, the occupancy shall be graded as light hazard.

6.2.5.2.

Ordinary Hazard Occupancy

6.2.5.3. Where the quantity of combustible material present is such that fires of moderate size may be expected, such as in mercantile occupancies, display rooms, auto showrooms, parking garages, light manufacturing, warehouses not classified as extra hazard and school shop areas, the occupancy shall be graded as ordinary hazard.

Extra Hazard Occupancy

6.2.5.4. Where the quantity of combustible material present is such that fires of severe magnitude may be expected, such as in woodworking, auto repair, aircraft servicing, mercantile storage areas, warehouses with high-piled combustibles and processes incorporating flammable liquids or combustible liquids, the occupancy shall be graded as extra hazard.

Subsection 6.2.6. Distribution

6.2.6.1. (1) Portable extinguishers required in Article 6.2.4.1. shall be located in conformance with this Subsection.

(2) Despite Sentence (1), in an unoccupied warehouse equipped with a fixed fire protection system, provision shall be made for portable extinguishers to be available for use by responding personnel.

(3) The location and number of portable extinguishers required under Sentence (2) shall be approved.

Building Protection

6.2.6.2. Portable extinguishers that are provided to protect a building shall be suitable for fighting Class A fires and be available for use at all times.

Occupancy protection

6.2.6.3. Portable extinguishers that are provided to protect a hazardous occupancy shall be those required in this Section for fighting Class A fires, Class B fires, Class C fires, Class D fires or Class K fires.

Extinguishers for Class A fires

6.2.6.4. Except as required in Article 6.2.6.5., portable extinguishers for Class A fires shall be provided in conformance with Table 6.2.6.A.

6.2.6.5. Where a floor area is less than that shown in Table 6.2.6.A., one portable extinguisher not less than the minimum size permitted shall be provided.

TABLE 6.2.6.A.

Forming Part of Article 6.2.6.4.

Basic Minimum	Maximum	

Extinguisher	Travel Distance	Maximum Area to be Protected per Extinguisher for Class A Fires, m2		
Rating for Area Specified	to Extinguisher, m	Light Hazard Occupancy	Ordinary Hazard Occupancy	Extra Hazard Occupancy
2A	25	600	300	Not Acceptable
3A	25	900	400	300
4A	25	1100	600	400
6A	25	1100	900	600
10A	25	1100	1100	900
20A	25	1100	1100	1100
40A	25	1100	1100	1100

Hose Stations in Lieu of Extinguishers

6.2.6.6. Up to one half of the number of portable extinguishers required in Table 6.2.6.A. may be replaced by hose stations.

Extinguishers for Class B fires

6.2.6.7. Except as required by Article 6.2.6.9., portable extinguishers for Class B fires shall be provided as required in Table 6.2.6.B.

6.2.6.8. (1) Where up to three portable extinguishers rated for Class B fires are used to satisfy the extinguisher rating specified in Table 6.2.6.B., the sum of the basic extinguisher ratings shall satisfy the requirements in Table 6.2.6.B.

(2) No more than three portable extinguishers shall be used to satisfy the requirements of Table 6.2.6.B.

TABLE 6.2.6.B.
Forming Part of Article 6.2.6.7.

Grade of Hazard	Basic Minimum Extinguisher Rating per Unit	Maximum Travel Distance to Extinguishers, m
Light	5B	9
	10B	15
Ordinary	10B	9
	20B	15
Extra	20B	9
	40B	15

Supplementary Protection

6.2.6.9. Portable extinguishers shall supplement fixed fire protection in Part 5 in accordance with Article 6.2.6.9. where a flammable liquid or combustible liquid is stored in an open container and where the liquid surface area exceeds 0.4 m².

Extinguishers for Class C fires

6.2.6.10. Portable extinguishers suitable for Class C fires shall be provided in or near service rooms containing electrical equipment.

Distribution

6.2.6.11. Distribution of portable extinguishers for Class C fires shall conform to the applicable provisions for the distribution of extinguishers for Class A fires or Class B fires in the vicinity of the electrical equipment.

6.2.6.12. Reference shall be made to Parts 2, 3, 4 and 5 for requirements of portable extinguishers for flammable liquids and combustible liquids, hazardous materials, processes and operations.

Subsection 6.2.7. Inspection, Testing and Maintenance

6.2.7.1. (1) Maintenance and testing of portable extinguishers shall be in conformance with NFPA 10, "Portable Fire Extinguishers".

(2) Portable extinguishers that are inspected in conformance with NFPA 10, "Portable Fire Extinguishers", are deemed to satisfy the inspection requirements of this Subsection.

Examination

6.2.7.2. Portable extinguishers shall be inspected monthly.

Tags

6.2.7.3. (1) Each portable extinguisher shall have a tag securely attached to it showing the maintenance or recharge date, the servicing agency and the signature of the person who performed the service.

(2) Sentence (1) does not apply where other approved records are maintained that show the maintenance or recharge date, the servicing agency and the signature of the person who performed the service.

Maintenance Records

6.2.7.4. A permanent record containing the maintenance date, the examiner's name and a description of any maintenance work or hydrostatic testing carried out shall be prepared and maintained for each portable extinguisher.

Maintenance After Use

6.2.7.5. Portable extinguishers shall be replaced or recharged after use in conformance with instructions given on the extinguisher nameplate.

6.2.7.6. Extinguisher shells, cartridges or cylinders that show leakage or permanent distortion in excess of specified limits or that rupture shall be removed from service.

6.2.7.7. Hydrostatic pressure tests shall be conducted at the original test pressure as stated on the nameplate.

Test Labels

6.2.7.8. (1) Where a portable extinguisher is tested, a label shall be fixed to the extinguisher after testing that indicates the month and year the hydrostatic pressure test was performed, the test pressure used and the name of the person or agency performing the test.

(2) Sentence (1) does not apply where a permanent record of the test is kept and is available to the fire department.

END OF THE SECTION