

Document Identification

DR

PROJECT MANUAL VOL. 2

Specifications Issued for Tender

Mechanical & Electrical

YORK REGION PARAMEDIC RESPONSE STATION #29

T-19-16

**107 Glen Cameron Road,
City of Markham**

Thomas Brown Architects Inc.

500-197 Spadina Avenue
Toronto, Ontario
M5T 2C8 Tel: 416-364-5710

Project No. 1509

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

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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 21 01 01 applies to and governs the work of all Sections of the 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 costliest 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 the Contract 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 Schedules shown on the Drawings 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. The Contractor shall ensure that the necessary number of copies of the returned set is prepared and distributed to the Owner, the 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 the Consultant.
 - .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 its

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 the 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 (e.g. 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, and the 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.
 - .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 Work. 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

- .3 Use latest editions and amendments in effect on the Closing Date of the tender of 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 the 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 the Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify the Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after the Contract award 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.

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. Include in the Contract 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 21 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 the Consultant, prior to Substantial Performance of the Work, 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 the 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 the Drawings and noted for Mechanical Division equipment. Starters and controls shall be Canadian General Electric or equivalent. 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 contracts.
 - 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 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.

- .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 Co.
 - 2. Westinghouse Electric Company
 - 3. Allen Bradley
 - 4. Schneider Electric - Square 'D'
 - 5. Cutler Hammer Canada
 - 6. Klockner-Moeller
 - 7. Commander Electric Inc.
 - 8. Schneider Electric - TelemecaniqueOr equivalent.

2.3 EQUIVALENTS AND ALTERNATIVES

- .1 Please refer to Section 01 25 00 – Product Substitution Procedures.
- .2 The Contract Price shall be based on the product related requirements specified in the Contract Documents.
- .3 Where the Contractor, with the Consultant's approval, uses equipment other than that first named, on which the design is based, it shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. The Contractor shall prepare and submit revised layouts to indicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by the 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 the Contract 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 the Consultant.
- .2 Apply, in writing, to the 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.
- .4 Refer to Section 01 25 00 – Product Substitution Procedures for further requirements.

3 Execution

3.1 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 in the Contract Documents, 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 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 the Consultant's approval before proceeding.
- .4 Adjust the location of materials and/or equipment as directed without adjustment to the 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 Contract 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 the 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 the Consultant's 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 of the Work.

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 the 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.

3.6 SPECIAL TOOLS AND SPARE PARTS

- .1 Within 30 days of award of the Contract, prepare a complete itemized list of special tools and spare parts and submit to the 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
- .5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

3.7 INSTRUCTION

- .1 Instruct and familiarize the 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 the 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 Performance of the Work.

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 its Subcontractors as required,
 - .3 Representatives of equipment manufacturers,
 - .4 Representatives of the Consultants,
 - .5 Representatives of the Owner.
- .4 The Contractor and its Subcontractors 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

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 21 01 01.

1.2 SECTION INCLUDES

- .1 Pipe, fittings, valves, and connections for fire protection systems.

1.3 REFERENCES

- .1 ASME Boiler and Pressure Vessel Code Section IX - Welding and Brazing Qualifications.
- .2 ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- .3 ASME B16.3 - Malleable Iron Threaded Fittings.
- .4 ASME B16.4 - Cast Iron Threaded Fittings.
- .5 ASME B16.5 - Pipe Flanges and Flanged Fittings.
- .6 ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.
- .7 ASME B16.11 - Forged Fittings Socket Welding and Threaded.
- .8 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .10 ASME B16.25 - Buttwelding Ends.
- .11 ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- .12 ASTM A135 - Electric-Resistance-Welded Steel Pipe.
- .13 ASTM A47/A47M - Ferritic Malleable Iron Castings.
- .14 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
- .15 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- .16 ASTM A795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- .26 AWS A5.8 - Filler Metal for Brazing and Braze Welding.
- .27 AWS D10.10 - Recommended Practices for Local Heating of Welds in Piping and Tubing.
- .28 AWWA C110 - Ductile-Iron and Gray-Iron Fittings 3" (76 mm) through 48" (1219 mm) for Welder.
- .29 AWWA C151 - Ductile Iron Pipe, Centrifugally Cast, for Water.
- .30 NFPA 13 - Installation of Sprinkler Systems.
- .31 NFPA 14 - Installation of Standpipe, Private Hydrants, and Hose Systems.
- .32 NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances
- .33 ULC - Fire Resistance Directory.
- .34 UL 262 - Gate Valves for Fire-Protection Service.
- .35 UL 312 - Check Valves for Fire-Protection Service.
- .36 UL 405 - Fire Department Connections.

1.4 SUBMITTALS FOR REVIEW

- .1 Section 21 01 01: Procedures for submittals.
- .2 Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings.
- .3 Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Project Record Documents: Record actual locations of components and tag numbering.
- .2 Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Installer Qualifications: Company specializing in performing the work of this section with a minimum of 5 years' experience.

1.7 REGULATORY REQUIREMENTS

- .1 Conform to OBC and OFC.
- .2 Sprinkler Systems: Conform work to NFPA 13.
- .3 Standpipe and Hose Systems: Conform to NFPA 14.
- .4 Welding Materials and Procedures: Conform to ASME Code.
- .5 Valves: Bear FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- .6 Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

- .1 Deliver and store valves in shipping containers, with labelling in place.
- .2 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.9 EXTRA MATERIALS

- .1 Provide two of valve stem packings for each size and type of valve installed.

2 Products

2.1 BURIED PIPING

- .1 Cast Iron Pipe: AWWA C151.
 - .1 Fittings: AWWA C110, standard thickness.
 - .2 Joints: AWWA C111, rubber gasket.
 - .3 Mechanical Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.
 - .4 Thrust Blocks and Anchors: not later than 1 part cement, 2.5 parts sand, 5 parts stone.

2.2 ABOVE GROUND PIPING

- .1 Steel Pipe: ASTM A53; Schedule 10.
 - .1 joined by welding or by roll grooved pipe and fittings:
 - .1 schedule 10 for sizes 5" (125mm) and smaller,
 - .2 0.134" (3.40mm) for 6" (150mm) diameter,
 - .3 0.188" (4.78mm) for 8" and 10" (200mm and 250mm) diameter.
 - .2 joined with threaded fittings or cut groove pipe and fittings:
 - .1 schedule 40 for sizes 6" (150mm) diameter and smaller,
 - .2 schedule 30 for sizes 8" (200mm) diameter and larger.
- .2 Pipe Fittings:
 - .1 Steel Fittings: ASME B16.9, wrought steel, butt welded;
 - .2 Cast Iron Fittings: ASME B16.1, flanges and flanged fittings;
 - .3 Malleable Iron Fittings: ASME B16.3, threaded fittings.
 - .4 Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts,

- nuts, and washers; galvanized for galvanized pipe.
- .5 Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocket and O-ring uniformly compressed into permanent mechanical engagement onto pipe.

2.3 PIPE HANGERS AND SUPPORTS

- .1 Conform to NFPA 13 and NFPA 14.
- .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 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 3-1/4" (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.

2.4 VALVES - GENERAL

- .1 cUL or ULC and FM approved, listed and labelled.
- .2 All valves controlling connections to water supplies shall be listed indicating valves.
- .3 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
- .4 Provide valves of the same manufacturer where possible.
- .5 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
- .6 All valves supplied for this project shall have a current and valid Canadian Registration Number for the Province of Ontario with TSSA. Suppliers shall provide a copy of the Statutory Declaration for valves, stamped, signed and dated by TSSA as validation of the CRN registration. This shall be included with the shop drawing submittal package.
- .7 Materials:
 - .1 Bronze: ASTM B62 or B61 as applicable
 - .2 Brass: ASTM B283 C3770
 - .3 Cast Iron: ASTM A126 Class B
- .8 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
- .9 Design and Testing:
 - .1 Bronze Gate & Check valves: MSS-SP-80
 - .2 Cast Iron Gate Valves: MSS-SP-70
 - .3 Cast Iron Globe Valves: MSS-SP-85
 - .4 Cast Iron Check: MSS-SP-71
 - .5 Butterfly Valves: MSS-SP-67
- .10 Acceptable manufacturers:
 - .1 Kitz
 - .2 Crane, Jenkins.
 - .3 Conbraco.
 - .4 NibcoOr equivalent.

2.5 ISOLATION VALVES

- .1 Electrically Supervised: ULC listed, FM approved, NO/NC SPDT dry contact switch suitable for electrical supervision on trouble circuit of facility fire alarm system. Valve monitoring switches shall be Potter Electric Signal and Manufacturing Limited or equivalent.

- .2 Up to 2" (50 mm):
 - .1 Construction: ULC listed, FM approved, 300 psig non-shock WOG, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz #25
- .3 2-1/2" (65 mm) and Larger:
 - .1 Construction: ULC listed, FM approved, 175 psi 1210 kPa CWP, outside screw and yoke, cast iron body, stem with ACME double threads, tapered solid wedge disc, flanged ends, renewable bronze seat rings.

2.6 CHECK VALVES

- .1 2-1/2 " (65 mm) and Larger:
 - .1 Construction: ULC listed, FM approved, 175psi (1210 kPa)CWP, iron body and bolted cap, bronze trim, bronze swing disc with replaceable bronze seat rings, flanged ends.
 - OR**
 - .2 Construction: ULC listed, FM approved, 175 psi (1210 kPa), Cast Iron body, 316 stainless steel shaft, Double Door Bronze Disc to B-62, Buna seat, 316 stainless steel spring, wafer style.

2.7 DRAIN VALVES

- .1 Construction: ULC listed and FM approved, brass ball valve with cap and chain, 3/4" (20 mm) hose thread.

3 Execution

3.1 PREPARATION

- .1 Ream pipe and tube ends. Remove burrs.
- .2 Remove scale and foreign material, from inside and outside, before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- .1 Install piping to NFPA 13 for sprinkler systems,
- .2 Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- .3 Install piping to conserve building space, to not interfere with use of space and other work.
- .4 Group piping whenever practical at common elevations.
- .5 Sleeve pipes passing through partitions, walls, and floors.
- .6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .7 Inserts:
 - .1 Provide inserts for placement in concrete formwork.
 - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.
 - .4 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.

- .8 Pipe Hangers and Supports:
 - .1 Install to NFPA 13.
 - .2 Install hangers to provide minimum 1/2" (15 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" (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - .5 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - .6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - .7 Provide copper plated hangers and supports for copper piping.
- .9 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- .10 Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding, maximum VOC content of 250 g/L..
- .11 Do not penetrate building structural members unless indicated.
- .12 Provide sleeves when penetrating footings. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- .13 When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- .14 Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- .15 Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- .16 Provide ball valves for shut-off or isolating service.
- .17 Provide drain valves at main shut-off valves, low points of piping and apparatus.
- .18 All control, drain and test connection valves shall be provided with permanently engraved and marked weatherproof metal or rigid plastic identification signs, secured with weather resistant chain or other approved method.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

- .1 Comply with General Requirements of Section 21 01 01.

1.2 SECTION INCLUDES

- .1 System design, installation, and certification.
- .2 Wet-pipe sprinkler assembly.
- .3 Fire department connections.

1.3 REFERENCES

- .1 NFPA 13 - Installation of Sprinkler Systems
- .2 NFPA 13A - Inspection, Testing and Maintenance of Sprinkler Systems
- .3 NFPA 15 - Water Spray Fixed Systems
- .4 NFPA 16 - Installation of Deluge Foam-Water Sprinkler System and Foam-Water Spray Systems
- .5 NFPA 16A - Installation of Closed-Head Foam-Water Sprinkler Systems
- .6 NFPA 25 - Water Based Fire Protection Systems
- .7 NFPA 26 - Supervision of Valves Controlling Water Supplies
- .8 NFPA 72 - Installation, Maintenance and Use of Protective Signaling Systems
- .9 NFPA 72E - Automatic Fire Detectors
- .10 NFPA 72G - Installation, Maintenance and Use of Notification Appliances for Protective Signaling Systems
- .11 NFPA 72H - Testing Procedures for Local, Auxiliary, Remote Station and Proprietary Protective Signaling Systems
- .12 NFPA 75 - Protection of Electronic Computer/Data Processing Equipment
- .13 NFPA 231 - General Storage
- .14 NFPA 231C - Rack Storage of Materials
- .15 NFPA 291 - Fire Flow Testing and Marking of Hydrants
- .16 FM - Factory Mutual Approval Guide.
- .17 ULC - Fire Resistance Directory.
- .18 UL 199 - Automatic Sprinklers for Fire-Protection Service.

1.4 SYSTEM DESCRIPTION

- .1 System to provide coverage for entire building.
- .2 Provide system to the Owner's Insurer's occupancy requirements.
- .3 Determine volume and pressure of incoming water supply from water flow test data.
- .4 Interface system with building fire alarm system.
- .5 Provide fire department connections where indicated in the Contract Documents.

1.5 SUBMITTALS FOR REVIEW

- .1 Product Data: Provide data on following components including manufacturers' catalogue information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
 - .1 sprinkler alarm valves
 - .2 flow switches
 - .3 water motor alarm
 - .4 Siamese pumper connection
 - .5 low pressure alarm switch
 - .6 ball drain valve
 - .7 sprinkler heads

- .8 shut-off valves
- .2 Preliminary layout: show finished ceiling areas indicating sprinkler locations coordinated with ceiling installation.
- .3 Hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories, indicating:
 - .1 Sheet number.
 - .2 Sprinkler description and discharge constant K.
 - .3 Hydraulic reference points.
 - .4 Flow l/s.
 - .5 Pipe size.
 - .6 Pipe lengths, center to center of fittings.
 - .7 Equivalent pipe lengths for fitting and devices.
 - .8 Friction loss in kPa at each reference point.
 - .9 Total friction loss between reference points.
 - .10 Elevation head in kPa at each reference point.
 - .11 Required pressure in kPa at each reference point.
 - .12 Velocity pressure and normal pressure if included in calculations.
 - .13 Notes to indicate starting points, reference to other sheets or to clarify data shown.
 - .14 Semi-logarithmic graph paper indicating water supply curves and systems requirements plus inside and outside hose requirements so as to present a graphic summary of complete hydraulic calculations.
- .4 Layout and Installation Drawings: Clearly indicate:
 - .1 Name and department or agency
 - .2 Location, including street address.
 - .3 Point of compass
 - .4 Ceiling construction.
 - .5 Full height cross section.
 - .6 Location of fire walls.
 - .7 Occupancy of each area or room.
 - .8 Location and size of blind spaces and closets.
 - .9 Any questionable small enclosures in which no sprinklers are to be installed.
 - .10 Size of city main in street, pressure and whether dead-end or circulating and if dead-end, direction and distance to nearest circulating main, with city main test results.
 - .11 Other sources of water supply, with pressure or elevation.
 - .12 Make, type and orifice size of sprinklers.
 - .13 Temperature rating and location of high temperature sprinklers.
 - .14 Number of sprinklers on each riser and on each zone.
 - .15 Number of sprinklers on each riser and total per floor.
 - .16 Make, type, model and size of alarm valves.
 - .17 Arrangement and operation of system controls.
 - .18 Kind and location of alarm bells.
 - .19 Cutting lengths of pipe or centre to centre dimensions.
 - .20 Crosses, riser nipples and sizes.
 - .21 Type of hangers, inserts and sleeves.
 - .22 All control valves, checks, drain pipes and test pipes.
 - .23 Small hand hose and hose equipment.
 - .24 When plans include underground pipe indicate: weight or class and size of pipe pits; depth of top of pipe below grade.
 - .25 Provisions for flushing.
 - .26 Name and address of contractor
 - .27 A summary sheet, clearly indicating:
 - .1 Date.
 - .2 Location.
 - .3 Name of department of agency.
 - .4 Building number or other identification.
 - .5 Description of hazard.
 - .6 Name and address of contractor or designer.
 - .7 Name of approving agency.

- .8 System design requirements, including design area of water application, minimum rate of application and area per sprinkler.
- .9 Total water requirements as calculated including allowance for inside hose and outside hydrants.
- .10 Water supply information.
- .5 Submit shop drawings to the Owner's insurance underwriter and authorities having jurisdiction for approval. Submit proof of approval to the Consultant.
- .6 Samples: Submit two of each style of sprinkler specified.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
- .2 Contractor's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
- .3 Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- .4 Warranty: Submit manufacturer warranty and ensure forms have been completed in the Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

- .1 Perform Work to OBC, NFPA 13 and the Owner's Insurer's requirements. Maintain one copy on site.
- .2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with a minimum of three years' documented experience.
- .3 Installer Qualifications: Company specializing in performing the work of this section with minimum five (5) years documented experience.
- .4 Design system under direct supervision of a Professional Engineer experienced in design of this work.

1.8 REGULATORY REQUIREMENTS

- .1 Conform to OBC, OFC, ULC.
- .2 Perform Work to NFPA 13.
- .3 Equipment and Components: Bear ULC and FM label or marking.
- .4 Products Requiring Electrical Connection: CSA Listed and classified by Underwriters Laboratories of Canada Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND PROTECTION

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

1.10 EXTRA MATERIALS

- .1 Provide extra sprinklers to NFPA 13.
- .2 Provide suitable wrenches for each sprinkler type.
- .3 Provide metal storage cabinet located adjacent to alarm valve.

2 Products

2.1 MANUFACTURERS

2.2 SPRINKLERS

- .1 Suspended Ceiling:
 - .1 Type: Semi-recessed pendant type with matching push on escutcheon plate.
 - .2 Finish: Chrome plated.

- .3 Escutcheon Plate Finish: Chrome plated.
- .4 Fusible Link: Glass bulb type temperature rated for specific area hazard.
- .2 Exposed Area Type:
 - .1 Type: Standard upright type with guard.
 - .2 Finish: Brass.
 - .3 Fusible Link: Glass bulb type temperature rated for specific area hazard.
- .3 Sidewall Type:
 - .1 Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate and guard.
 - .2 Finish: Chrome plated.
 - .3 Escutcheon Plate Finish: Chrome plated.
 - .4 Fusible Link: Glass bulb type temperature rated for specific area hazard.
- .4 Dry Sprinklers:
 - .1 Type: Standard pendant type with matching push on escutcheon plate.
 - .2 Finish: Brass.
 - .3 Escutcheon Plate Finish: Brass.
 - .4 Fusible Link: Glass bulb type temperature rated for specific area hazard.
- .5 Concealed Pendant:
 - .1 Cover plate attachment with 1/2" (13mm) assembly adjustment.
 - .2 Smooth aesthetic ceiling profile.
 - .3 Factory installed protective cap.
 - .4 Factory painted (confirm colour with architect prior to ordering)
- .6 Guards: Finish to match sprinkler finish.

2.3 PIPING SPECIALTIES

- .1 Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with pressure retard chamber and variable pressure trim; with test and drain valve.
- .2 Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy chrome plated gong and motor housing, nylon bearings, and inlet strainer.
- .3 Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.
- .4 Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.
- .5 Fire Department Connections:
 - .1 Type: Flush mounted wall type with chrome plated finish.
 - .2 Outlets: Two way with thread size to suit fire department hardware; threaded dust cap and chain of matching material and finish.
 - .3 Drain: 3/4" (19 mm) automatic drip, outside.
 - .4 Label: "Sprinkler - Fire Department Connection".
- .6 Supervisory Switches: As manufactured by Potter.

3 Execution

3.1 INSTALLATION

- .1 Install to NFPA 13.
- .2 Install equipment to manufacturers instructions.
- .3 Install buried shut-off valves in valve box. Provide post indicator.
- .4 Provide approved reduced pressure principle backflow preventer assembly at sprinkler system water source connection.
- .5 Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.
- .6 Locate outside alarm gong on building wall as indicated.
- .7 Place pipe runs to minimize obstruction to other work.
- .8 Place piping in concealed spaces above finished ceilings.
- .9 Centre sprinklers in two directions in ceiling tile and provide piping offsets as required.

- .10 Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- .11 Install Dry pipe sprinkler system for the ceiling space, refer to architectural drawings for ceiling/attic details.
- .12 Dry pipe sprinkler system with all required accessories to make it fully operational.
- .13 Flush entire piping system of foreign matter.
- .14 Hydrostatically test entire system.
- .15 Require test be witnessed by Fire Marshall.

3.2 INTERFACE WITH OTHER PRODUCTS

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

3.3 OPERATING SEQUENCE FOR WET SPRINKLERS

- .1 In Normal Set Condition: The system piping is filled with water.
 - .1 All water supply control valves open and secured.
 - .2 Alarm test shut-off valve in "ALARM" position.
 - .3 Water gauge valves open.
 - .4 The water supply pressure gauge (lower gauge) equals that of the known service-line pressure. The system pressure gauge (upper gauge) reading is equal to or greater than the water supply pressure gauge reading.
 - .5 Incoming power to all alarm switches on.
 - .6 Main-drain valve, auxiliary drain valves and inspectors test valves tightly closed.
 - .7 The sprinkler head cabinet contains appropriate replacement sprinklers and wrenches.
 - .8 Temperature maintained above freezing for entire system.
 - .9 If Fire Department connection is used, make sure the automatic drip valve is free allowing accumulated water to escape.
 - .10 Sprinklers in good condition and unobstructed.
- .2 In Fire Condition:
 - .1 The heat produced operates a sprinkler allowing the water to flow.
 - .2 The alarm valve clapper is opened by the flow of water allowing pressurized water to enter the alarm port to activate the connected alarm devices.
 - .3 When using variable pressure trim the water flowing through the alarm port overcomes the retarding chamber's drain restriction, filling the retarding chamber then activating the connected alarm devices.
 - .4 The alarms will continue to sound until the flow of water is manually turned off.
- .3 In Service condition:
 - .1 The system should be placed out of service only for repairs.
 - .2 The work to be done must be completed in a manner to minimize the time that the system must be out of service.
 - .3 All hazardous activities in the effected area shall be terminated until the system is placed back in service.
 - .4 Any system impairment shall be coordinated with the Owner, local authority having jurisdiction and other related parties.
 - .5 Provide a roving fire patrol in the area covered by the system until the system is back in service.
 - .6 Prior to turning off any valves or activating any alarms, notify local security guards and/or central alarm station so that a false alarm will not be signaled and result in a local fire department response.

3.4 TESTING AND INSPECTION

- .1 Test automatic sprinkler in accordance with requirements of NFPA 13 and NFPA 25.
 - .1 hydrostatically tested at 50 psi (3.5 bar) in excess of system working pressure and minimum test pressure of 200 psi (13.8 bar) for 2-hr.
 - .2 When cold weather prevents testing with water, an interim test may be conducted with air. The hydrostatic test with water must be conducted subsequently when conditions permit.

- .3 modifications affecting fewer than 20 sprinklers and modifications that cannot be isolated shall not require testing in excess of system working pressure. Modifications affecting more than 20 sprinklers shall be isolated and tested at not less than 200 psi (13.8 bar) for 2-hr.
- .4 loss shall be determined by a drop-in gauge pressure or by visible leakage.
- .2 Arrange and pay for all reviews and inspections required by:
 - .1 Local inspection authority.
 - .2 the Owner's insurance authority.
- .3 Coordinate testing of automatic sprinkler systems with fire alarm system verification to ensure that all devices are fully tested.

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 in the Contract Documents,
 - .2 Division 1 requirements and documents referred to therein.
- .2 Section 22 01 01 applies to and governs the work of all Sections of Divisions 21, 22 and 23.
- .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 costliest 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 Refer to Mechanical/Electrical Equipment Schedule in the Contract Documents for extent of wiring and electrical characteristics.
- .11 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 the 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. The Contractor shall ensure that the necessary number of copies of the returned set are prepared and distributed to the Owner, the Consultant, the site, and to relevant 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 the Consultant.
 - .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 Divisions 21, 22 and 23. 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 (e.g. 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, the Contractor, and the 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.
 - .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 Work. 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 the 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 the Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after the Contract Award 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.

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 the Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without the Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner. Include in the Contract 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 the Consultant, prior to Substantial Performance of the Work, manufacturer's written warranties covering periods longer than two years 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 the 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 Divisions 21, 22 and 23 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 the 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 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.
- .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 Divisions 21, 22, and 23. 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 Co.
 - 2. Westinghouse Electric Company
 - 3. Allen Bradley
 - 4. Schneider Electric - Square 'D'
 - 5. Cutler Hammer Canada
 - 6. Klockner-Moeller
 - 7. Commander Electric Inc.
 - 8. Schneider Electric - TelemecaniqueOr equivalent.

2.3 EQUIVALENTS AND ALTERNATIVES

- .1 Please refer to Section 01 25 00 – Product Substitution Procedures.
- .2 The Contract Price shall be based on the product related requirements specified in the Contract Documents.
- .3 Where the Contractor, with the Consultant's approval, 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. The Contractor shall prepare and submit revised layouts to indicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by the 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 the Contract 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 the Consultant.
- .2 Apply, in writing, to the 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.
 - .4 Refer to Section 01 25 00 – Product Substitution Procedures for further requirements.

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 in the Contract Documents 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 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 the 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 Contract Price shall be based on the layout and specifications as shown in the Contract 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 the 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 the 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 of the Work.

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 the 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 the 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 the 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 the 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 Performance of the Work.

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 its Subcontractors as required,
 - .3 Representatives of equipment manufacturers,
 - .4 Representatives of the Consultants,
 - .5 Representatives of the Owner.
- .4 The Contractor and its Subcontractors 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

1 General

1.1 SCOPE / SUMMARY

- 1.1.1 Provide all metering equipment required to monitor consumption by end use type.

1.2 RELATED SECTIONS

- 1.2.1 Division 23 09 13 Instrumentation and Control Devices for HVAC
- 1.2.2 Division 26 09 13 – Electrical Power Monitoring

2 Design Requirements / Products

2.1 END USES TO BE MONITORED

- 2.1.1 Provide water meters for all end uses, including but not limited to:
 - 2.1.1.1 Facility incoming domestic cold water

2.2 METERING EQUIPMENT

2.2.1 Meters

- .1 Provide water meters complete with bypass piping arrangement or other means to remove or isolate for service without interruption to water flow.
- .2 Materials shall be compatible with the systems in which they are installed at all potential operating temperatures and pressures.
- .3 Meters shall provide a pulse output scaled to an appropriate volume. In general, provide a scaled pulse output of 1 litre per pulse unless high consumption would result in pulses too frequent to be reliably captured by the pulse counting equipment.
- .4 Meters requiring power shall be hard-wired. Battery powered units are not acceptable.
- .5 Provide meters with readout of totalized volume.
- .6 Accuracy +/- 1.5% in expected operating flow range.

2.2.2 Pulse Counting Equipment

- .1 Internet Protocol (IP) based data logger complete with:
 - 1. Built-in web server.
 - 2. Capable of operating with a dedicated IP address (to be provided by the Region).
 - 3. Communications Protocols
 - a. HTTP capable of pushing data to 3rd party applications/databases.
 - b. Modbus TCP
 - 4. Built-in real-time and historic graphics accessible with any HTML 5 internet browser (computer, tablet, phone) on the Region's network.
 - 5. Real-time clock with battery backup and email alert for battery end of life.
 - 6. Ability to export all stored trend data to comma separated value (.csv) or Microsoft Excel format for importing into spreadsheets.
 - 7. Published application programming interface (API) allowing data to be retrieved from the pulse counter via non-proprietary means, such as JavaScript Object Notation (JSON).
 - 8. Multiple inputs per unit MJL4. Provide minimum 2 spare inputs for future additional meters. Location of spare inputs to be determined by the Region.

9. Minimum two universal inputs for addition of 0-10V and 0-20mA/4-20mA sensors.
10. Built-in trending and data storage:
 - a. 3 years of consumption data at 5 minute intervals for each input
 - b. Stored in non- volatile memory.
11. Battery/power backup (for pulse counting):
 - a. Lasting a minimum of 72 hours.
 - b. Rechargeable.
 - c. Email alert for battery end of life.
12. No special software required to set up pulse counting equipment or access data.
13. Security:
 - a. Unrestricted access to data and graphics over the Region's network.
 - b. Password protection for access to setup, changing settings/parameters and deleting data.
14. Ability to measure and trend the following data:
 - a. Totalized consumption (m³)

.2 Acceptable product: z3 Controls Inc.NetMeter OMNI or equivalent.

3 Execution

3.1 INSTALLATION REQUIREMENTS

- .1 Install pulse counting equipment in a painted, hinged NEMA 1 enclosure.
- .2 All communication and pulse cables to be continuous. No splicing is allowed.
- .3 Affix York Region Property Services Branch Asset ID tag to data logging unit prior to installation.
- .4 Connect data logging equipment to the Region's IT network.
 1. Meter to be supplied and installed by mechanical contractor with bypass and isolation valves.
 2. A separate meter to be installed downstream of utility water meter for BAS with pulse contacts.
- .5 Commission pulse counting equipment:
 1. Ensure data logger corresponds to physical meter reading
 2. Ensure latest available firmware version is installed in pulse counter.
 3. Obtain Network information from York Region project manager and program into pulse counter, including IP address, subnet mask, default gateway, primary and secondary DNS addresses.
 4. Set pulse counter clock to current local time.
 5. Set up email alerts as requested by the Region's project manager.
 6. Set default homepage to display real-time graphs and consumption statistics.
 7. Verify pulse counter information is viewable through a web browser on a device on the Region's network.
 8. Complete and submit Energy Meter Commissioning Form.
 9. Provide training on pulse counter software use to Region staff including Facilities Operations and Maintenance and Corporate Energy Services.

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 Sovent 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 the Ontario Building Code. 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 Ontario Building 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 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 SANITARY 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 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, solvent.
 - .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.
 - .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 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 are subject to approval by the Consultant or the Owner acting reasonably.

2.10 ISOLATION VALVES

- .1 Up To and Including 2" (50mm) - Ball type
 - .1 Manufacturer: Kitz Corporation #69AMLL or equivalent.
 - .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 Corporation 6122EL or equivalent.
 - .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 Corporation 10. or equivalent.
 - .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 Corporation 76 (Globe) or equivalent.
 - .2 Construction: Cast iron body globe
- .3 2-1/2" (65 mm) and Larger - Butterfly type
 - .1 Manufacturer: Kitz Corporation 6122EL or equivalent.
 - .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 Corporation 23 or equivalent.
 - .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 Corporation 78 or equivalent.
 - .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 Corporation 68C or equivalent.
 - .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 International Inc. Model GD 24.
 - .2 Watts Canada Model Series 223.
 - .3 Substitutions: Refer to Section 01 25 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 International Inc. Model GD 200.200H.
 - .2 Watts Canada Model Series N223.
 - .3 Substitutions: Refer to Section 01 25 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 Canada Model Series 40.
 - .2 Substitutions: Refer to Section 01 25 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 Specialty 351M or equivalent.
 - .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 Specialty 758 or equivalent.
 - .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:
 - .1 Size 2" (50 mm) and Under:
 - .1 Manufacturers: Mueller Steam Specialty 11M or equivalent.
 - .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 Specialty 758 or equivalent.
 - .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" (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.
- .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, exiting 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 Hydrants.
- .5 Backflow preventers.
- .6 Water hammer arrestors.
- .7 Oil Interceptor.
- .8 Trap Seal Primers.

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 a minimum of 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 GENERAL

2.2 ROOF DRAINS

.1 Built - Up Roofs

- .1 Manufacturer: Watts Canada Drainage Model RD100-BED-W-1 or equivalent.
- .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 Landscaped Roofs

- .1 Manufacturer: Watts Canada Drainage Model RD200-GSS-BED or equivalent.
- .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.
 - .5 Perforated stainless steel ballast guard extension.

2.3 FLOOR DRAINS

- .1 Floor Drain (FD):
 - .1 Watts Canada Drainage model FD-100-C-5 or equivalent.
 - .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 Canada Drainage Model FD-100-C-EG or equivalent.
 - .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 or equivalent
 - .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.

2.4 TRAP SEAL PRIMERS

- 1. Individual Traps:
 - 1. Watts Canada Drainage model MS-810 or equivalent.
 - 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 or equivalent. Primer suitable for up to 8 drains.

2.5 CLEANOUTS

- .1 Exterior Surfaced Areas:
 - .1 Watts Canada Drainage model CO-200-RFC or equivalent
 - .2 Round cast nickel bronze access frame and non-skid cover.
- .2 Exterior Unsurfaced Areas:
 - .1 Watts Drainage model CO-300-MF or equivalent.
 - .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 or equivalent.
 - .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 or equivalent.
 - .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 or equivalent.
 - .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-300-2 (Duo-Temp Mild climate Wall Hydrant Encased Type)
 - .2 Concealed key operated dual-temp mild climate wall hydrant with nickel bronze box and door, polished bronze hydrant face, 3/4" (19 mm) hose connection, all bronze head, seat casing and internal working parts, galvanized wall casing and hydrant key. "

2.7 BACKFLOW PREVENTERS

- .1 Reduced Pressure Backflow Preventers:
 - .1 Manufacturers:
 - .1 Watts Canada Model 909.
 - .2 ITT lawler Model RZ.
 - .3 Baukman Model BF-299.
 - .4 Febco Model 825Y
 - .4 Substitutions: Refer to Section 01 25 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 Canada Drainage Series 05 or equivalent.
- .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 INTERCEPTOR

- 1 Watts Canada Drainage OI-525-X or equivalent.
- 2 Oil interceptor with extra heavy duty cover and extension as required.

2.10 IN-LINE WATER FILTER

- 1 Single housing water treatment system with a drop-in 10" (250 mm) cartridge, reduce sediment down to 0.5 micron and to reduce chlorine, taste & odor at a flow rate of 1.5 gpm for 15,000 gallons, scale inhibiting technology, protection against the precipitation and accumulation of scale and provides a protective barrier to help guard against corrosion, high capacity activated carbon filtration, stainless steel mounting bracket and full-flow inlet shut-off valve, built-in pressure gauge, 1/2" (15 mm) inlet and outlet connection. OptiPure FXI-11 or equivalent.
- 2 Provide two (2) replacement filter cartridges for each installed water cooler filter. OptiPure CTOS-10 or equivalent.

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 Ontario Building 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 the Consultant prior to installation of drains. Coordinate installation with roofing trade.
- 3

3.5 WALL HYDRANTS

- .1 Locate wall hydrants where indicated in the Contract Documents.
- .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 the 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 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 Ontario Building Code.
- .3 Fill with appropriate media as required and turn over spare media to the Owner.

3.9 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.

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
- .7 Eye and Face wash, valves, fittings, accessories, signs

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 the 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 a minimum of five years' documented experience.
- .2 Installer Qualifications: trades licence with a minimum of 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 Plumbing Corporation
 - .2 Kohler Co.
 - .3 Toto Ltd
 - .4 EljerOr equivalent.
3. Stainless Steel fixtures:
 - .1 Manufacturer: Acorn Engineering Company
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Bradley Corporation
 - .2 Willoughby IndustriesOr equivalent
4. Seats
 - .1 Manufacturer: Centoco Manufacturing Corporation
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Benecke
 - .2 Olsonite
 - .3 Kohler Co.
 - .4 Bemis Manufacturing Company or equivalent.
5. Mechanical Flush Valves
 - .1 Manufacturer: Sloan Valve Company "Regal"
 - .2 Other acceptable manufacturers offering equivalent products:
 - .1 Zurn Industries
 - .2 Cambridge Brass Inc.
 - .3 Watts - PowersOr equivalent
6. Diverter Valves
 - .1 Manufacturer: Watts - Powers
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Kohler Co.
 - .4 Sloan Valve Company
 - .5 Substitutions: Refer to Section 01 25 00.
7. Carriers
 - .1 Manufacturer: Watts Ancon
 - .2 Other acceptable manufacturers offering equivalent products.
 - .1 Zurn Industries
 - .2 Jay R. Smith Manufacturing Co.
 - .3 MIFAB Inc.
 - .4 Substitutions: Refer to Section 01 25 00.Or equivalent

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

1. **American Standard Madera Flowise Right Height Elongated 419mm high #3461.001.020 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 or equivalent.
2. **Centoco Manufacturing Corporation #820STS.001 heavy duty toilet seat**, for elongated bowl open front, white solid plastic, with cover, reinforced stainless steel check hinges, metal flat washers stainless steel posts and nuts.
 3. **Sloan Valve Company Regal #111-XL-CP**, exposed manual Flushometer for Top Spud toilet, chrome plated, 4.8L maximum 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 or equivalent.
 4. **Provide Floor Flange**, (same material as the connecting pipe drain), with all brass bolts and with rubber gasket

2.3 COUNTER MOUNTED SEMI COUNTER BASIN –TWO HANDLE FAUCET POINT OF USE THERMOSTATIC MIXING VALVE (L1)

1. **American Standard Mezzo #9960.803 basin**, 3 holes, 8" (203 mm) center, 559 mm x 546 mm x 210 mm (22" x 21-1/2" x 8-1/4") high, semi-counter, rear overflow, faucet ledge, space saving design, mounting kit or equivalent. **Provide basin rim sealant.**
2. **Chicago Faucets #404-317XKABCP two (2) Handle Faucet**, chrome plated, 8" (203 mm) centerset, lead free solid brass with one piece concealed rough body, 1/4 turn ceramic disc valve cartridges, 1.9LPM at 414 Kpa pressure compensating Softflo aerator outlet, 127 mm (5") projection cast brass spout, 102 mm (4") metal vandal proof wristblade handles with blue and red index buttons or equivalent.
3. **Lawler Manufacturing Co. #570-86820, Point of Use Thermostatic Water Mixing Valve**, nickel plated bronze body, temperature adjusting spindle, 10 mm (3/8") inlets and outlet FNPT connections, integral checks, offer temperature range between 35 °C (95 °F) and 46 °C (114.8 °F) or equivalent. Set valve temperature at 46 °C (114.8 °F). **Provide tee, adaptors and flex. copper tubing to suit installation. Provide tempered water to hot side of faucet.**
4. **McGuire Manufacturing Co., Inc #155WC Offset Open Grid Drain**, cast brass one piece top, 17 GA. (1.5 mm) mm tubular 32 mm (1-1/4") tailpiece or equivalent.
5. **McGuire Manufacturing Co., Inc #LFH170BV, Faucet Supplies**, chrome plated polished brass, commercial duty 1/4 turn ball valve angle stops, 13 mm (1/2") I.D. Inlet x 127 mm (5") horizontal extension tubes, combination V.P. Loose key handles, escutcheon and flexible copper risers or equivalent.
6. **McGuire Manufacturing Co., Inc #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 or equivalent.
7. **McGuire Manufacturing Co., Inc PROWRAP #PW2000WC Sanitary Covering vandal-resistant**, flexible seamless moulded closed-cell PVC resin, formulated with anti-microbial additive to limit the growth of fungus and bacteria, to exposed piping (to protect against heat/contusions) as per local codes or equivalent.

2.4 SHOWER WALL MOUNTED SHOWER SEAT VALVE AND HANDSHOWER (SH1)

1. **Chicago Faucets #SH-PB1-00-000/151-WB-WS**, pressure balancing, washerless ceramic drip-free disc valve cartridge, metal wall escutcheon or equivalent.
2. **Chicago Faucets #151-VB-WS hand shower slide bar, 24" (610 mm)**, 6 LPM maximum, spray head, 60" (1524 mm) flexible metal hose, wall supply elbow with flange, in-line vacuum breaker or equivalent.
3. **Chicago Faucets #620-LCP Showerhead**, chrome plated finish, 5.7 LPM (1.5 GPM) flow rate @ 80 psi, pressure compensating flow control device, swivel ball joint or equivalent.
4. **Chicago Faucets #763-CP In-wall 3-Way Diverter Trim and valve kit**, metal lever handle, brass valve construction, rotational control to alternate water flow between three (3) different shower outlets equivalent.
5. **Watts Water Technologies Inc. #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 or equivalent.
6. **Provide floor drain at entrance to shower and built-up floor. Provide P-Trap**, same material as the connecting pipe drain.

2.5 COUNTER MOUNTED SINK- TWO HANDLE FAUCET (S1)

1. **Franke Kitchen Systems LLC. Commercial #LBS6808-1/3 Single Bowl Countertop Mount Sink**, 3 holes, 8" (203 mm) center, 508 mm (20") wide x 521 mm (20-1/2") x 203 mm (8") high deep, counter mounted, backledge, grade 18-10 20 GA. (0.9 mm) type 302 stainless steel, self-rimming, satin finish rim and bowls, mounting kit provided, fully undercoated to reduce condensation and resonance, factory applied rim seal, 3-1/2" (89 mm) crumb cup waste assembly with 1-1/2" (38 mm) tailpiece or equivalent.
2. **Chicago Faucets #1100-L9-317XKABCP two (2) Handle Faucet**, chrome plated, 8" (203 mm) centerset, lead free cast brass body, ceramic 1/4 turn operating cartridge, 5.7 LPM at 414 Kpa pressure compensating Softflo aerator outlet, 229 mm (9") projection L type swing spout, 102 mm (4") metal vandal proof wristblade handles with blue and red index buttons. **Supply Provide Faucet Supplies**, chrome plated all metal construction, light duty residential angle stops, escutcheons and flexible metal risers, **low lead** or equivalent.
3. **Provide P-Trap**, adjustable all metal construction, 38 mm (1-1/2") size, and escutcheon or equivalent.

2.6 SERVICE / MOP SINK - TWO HANDLE FAUCET (MS1)

1. **Stern Williams Co. Inc. #SB-300 Service / Mop Sink**, 610 mm (24") wide x 914 mm (36") x 305 mm (12") high 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" (76 mm) outlet or equivalent.
Chicago Faucets #897-XK-CP Wall Mounted two (2) Handle Faucet, chrome plated, 8" (203 mm) centerset, solid brass exposed body, 1/4 turn ceramic disc valve cartridges, unrestricted hose end outlet, 203 mm (8") projection spout with atmospheric vacuum breaker and bucket hook, 60 mm (2-3/8") metal vandal proof lever handles with blue and red index buttons. **Stern Williams Co. Inc. T-35 Hose and Wall Hook** 36" (914 mm) long hose with 3/4" (19 mm) chrome coupling, stainless steel wall bracket. **Stern Williams T-40 Mop Hanger** stainless steel #4 finish, 24" (610 mm) long with 3 rubber spring loaded clips. **Stern Williams Co. Inc. BP Back Splash Panel** 20 GA. (0.9 mm) type 304 stainless steel or equivalent.
2. **Provide P-Trap**, same material as the connecting pipe drain.

2.7 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 is third party certified by IAPMO to meet ANSI Z358.1-2014, the Uniform Plumbing Code cUPC and the National Plumbing Code of Canada or equivalent.
2. **Eyewash/Facewash fixture should be installed 4 to 10 feet from the mixing valve. McGuire Manufacturing Co. Inc. #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 or equivalent.
3. **Provide p-trap for drain**. For Thermostatic Mixing Valve, Lawler model # 911E/F or equivalent.

2.8 EMERGENCY EYE WASH TEMPERED WATER MIXER STATION

1. **Lawler Manufacturing Co. #911E/F, Emergency Thermostatic Mixing Valve for Eyewash or Eye/Face Wash**, 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) or equivalent.

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 Section 01 77 00 - Execution Requirements: Adjusting installed work.
- .2 Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.5 CLEANING

- .1 Section 01 77 00 - Execution Requirements: Cleaning installed work.
- .2 Clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

- .1 Section 01 77 00 - Execution Requirements: Protecting installed work.
- .2 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 Anti-Scale System
- .2 Fuel Fired Domestic Water Heater
- .3 Domestic Hot Water Re-Circulation Pump.

1.3 RELATED SECTIONS

- .1 Section 01 33 00 –Submittal Procedures.
- .2 Section 01 60 00 – Products and Workmanship.
- .3 Section 01 78 00 - Project Closeout.
- .4 Section 23 05 48 - Vibration Isolation.

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 Section 01 33 00: 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 tappings, and performance data.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- .1 Section 01 33 00: 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 the 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 in the Contract Documents.

1.9 DELIVERY, STORAGE, AND PROTECTION

- .1 Section 01 60 00: Transport, handle, store, and protect products.
- .2 Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.10 WARRANTY

- .1 Section 01 78 36.
- .2 Provide five year manufacturer warranty for domestic water heaters packaged water heating systems in-line circulator.

1.11 EXTRA MATERIALS

- .1 Section 01 77 00.
- .2 Provide two of pump seals.

2 Products

2.1 FUEL FIRED DOMESTIC WATER HEATERS

- .1 Manufacturer: A.O.Smith Watwer Product Company – Model No. BTH 120 (A) (Natural Gas) – Cyclone MXi modulating with 95% thermal efficiency or equivalent.
- .2 Other acceptable manufacturers offering equivalent products with similar or higher efficiencies.
 - .1 Leslie Controls Inc.
 - .2 Armstrong International Inc.
 - .3 Graham CorporationOr equivalent.

2.4 ANTI-SCALE SYSTEM

- .1 Manufacturer: Watts Canada Model OF1665-75 (75 GPM).
- .2 Equivalent products by other manufacturers.

2.5 DHW RECIRCULATION PUMP P-1

- .1 Manufacturer: Taco Comfort Solutions Model Plumb 'n' plug c/w aquastat 4 USGPM @3FT HEAD, 1/25 HP 115 V – 1 PHASE
- .2 Equivalent products by other manufacturers

3 Execution

3.1 INSTALLATION

- .1 Install water heaters to 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 Anti-Scale System:
 - .1 Install Anti-Scale System as per manufacturers installation instructions.
- .6 Domestic Hot Water Re-Circulation Pump: P-2
 - .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 Section 01 33 00: Procedures for submittals.
- .2 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 the 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 and Article A-15 of the Agreement Between Owner and Contractor.

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 Corporation
 - .2 Crane & Jenkins Valve Group Inc.
 - .3 Conbraco Industries Canada
 - .4 Nibco Inc.

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 Canada or equivalent 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 Divisions 21, 22, and 23.
- .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;
 - a. EEMAC 1 enclosure if housed within a weatherproof cabinet.
 - b. 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 in the Contract Documents 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. 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. The General Contractor shall ensure that the necessary number of copies of the returned set are prepared and distributed to the Owner, the Consultant, the General Contractor, the site, and to relevant 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 the Consultant,.
 - .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 Divisions 21, 22 and 23. 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 (e.g. 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, the Contractor and the 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.
- .8 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.
- .9 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Work. Refer to paragraph 3.2.5 and to Division 1 for requirements.
- .10 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.
- .11 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 the 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 the 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 the 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 the Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after award of the 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..

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 the Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without the Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner Facilities Group in Property Services. Include in the Contract 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 the Consultant, prior to Substantial Performance of the Work, manufacturer's written warranties covering periods longer than two 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 the 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 Subcontractor shall provide all motor starters and associated controls required and as scheduled on drawings and noted for Mechanical equipment. Starters and controls shall be Canadian General Electric or equivalent. 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 the 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 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.
- .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 s 21, 22, and 23. 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 Co.
 2. Westinghouse Corporation
 3. Allen Bradley Co.
 4. Square 'D' Co.
 5. Cutler Hammer Canada
 6. Klockner-Moeller Parts
 7. Commander
 8. Telemecanique Co.Or equivalent.

2.3 EQUIVALENTS AND ALTERNATIVES

- .1 Please refer to Section 01 25 00 – Product Substitution Procedures.

- .2 The Contract Price shall be based on the product related requirements specified in the Contract Documents.
- .3 Where the Contractor, with the approval 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. The Contractor shall prepare and submit revised layouts to indicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by The 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 the Contract 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 the Consultant.
- .2 Apply, in writing, to the 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.
- .4 Refer to Section 01 25 00 – Product Substitution Procedures for further requirements.

3 Execution

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 in the Contract Documents, 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 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 the 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 Contract 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 the 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 the 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 of the Work.

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 the 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 the 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.
- .5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

3.8 INSTRUCTION

- .1 Instruct and familiarize the 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 the 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 Performance of the Work.

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 its Subcontractors as required,
 - .3 Representatives of equipment manufacturers,
 - .4 Representatives of the Consultants,
 - .5 Representatives of the Owner.
- .3 The Contractor and its Subcontractors 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.

- .4 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.
- .5 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.
- .6 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.
- .7 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

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 International
 - .2 Myatt E & Co. Inc.
 - .3 Hunt ManufacturingOr equivalent.
- .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.

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 to 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 00. 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 53.**
- .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	Copper Tube
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.

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.
.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 Solvent 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 Section 01 33 00: Submission procedures.
- .2 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 applicable Codes including the Ontario Building Code 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 Vibration Isolation & Seismic Control Manufacturers Association.
- .2 Acceptable manufacturers:
 - .1 Vibron/Kinetics Noise Control
 - .2 VAW Systems Ltd.
 - .3 Korfund Dynamics
 - .4 Masdom Inc.Or equivalent.

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 Contractor shall ensure that its mechanical Subcontractor 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 Testing, adjustment, and balancing of plumbing systems.
 - .3 Measurement of final operating condition of HVAC systems.
- .2 This Section shall verify correct operation of;
 - .1 piping systems,
 - .2 air systems,
 - .3 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 the 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 the 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.
- .8 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 21, 22 and 23
- .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 21, 22 and 23

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 Professional Engineer experienced in the performance of this work
- .3 Acceptable agencies include;
 - .1 National Air Balance Inc.
 - .2 Clark Balancing Ltd.
 - .3 Dynamic Flow Balancing Ltd.Or equivalent.

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 Performance of the Work.

1.11 SCHEDULING

- .1 Schedule and provide assistance in final adjustment and test of life safety system with Fire Prevention Office at the Town of Markham

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.
- .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 the 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 WATER SYSTEM PROCEDURE

- .1 Adjust water systems to provide required or design quantities.
- .2 Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- .3 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- .4 Effect system balance with automatic control valves fully open to heat transfer elements.
- .5 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- .6 Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

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 the 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 21, 22 and 23 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 installing contractor has given proper advance notification to all persons required to be present as tests are conducted.
- .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 the installing contractor's start-up procedures.
- .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 all 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 installing 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 installing 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

- the installing contractor of repairs required.
- .14 Verify that manufacturer's start-up procedures have been performed and that equipment is installed in accordance with the manufacturers 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 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 to the 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 minimum 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 Insulation
 - .2 Knauf Insulation
 - .3 Schuller International Inc.Or equivalent.
- 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 25 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 Canvas 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. 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 Technical Identification and Analysis Centre 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	rigid	1" (25mm)
Air supply round	flexible	1" (25mm)
Exhaust 6' (2m) from outside) rectangular	rigid	3" (75mm)
Exhaust 6' (2m) from outside) round	flexible 3"	(75mm)
Fresh air intake rectangular	rigid	3" (75mm)
Exhaust air plenums	rigid	3" (75mm)
Ductwork outdoors	rigid	3" (75mm)
Rectangular air supply runouts to terminal units <10' (3m) in length	rigid	1" (25mm)
Round air supply runouts to terminal units <10' (3m) in length	flexible 1"	(25mm)
Duct mounted cooling coils	rigid	1 1/2" (40mm)

- .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 a minimum of 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 Insulation
 - .2 Knauf Insulation
 - .3 Schuller International Inc.Or equivalent.
- .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 01 25 00
- .2 Insulation: ASTM C-1126 Phenolic Foam Thermal Insulation, Chlorofluorocarbons and hydrochlorofluorocarbons 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)
 - .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 equivalent 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 equivalent.
- .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) or equivalent. The 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 equivalent.
 - .2 Polyguard 650 LT Liquid Adhesive is required at application temperatures 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 Fabrication 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 equivalent.
- .8 Pipe and Hanger Supports
 - .1 Pipe support load bearing insulation shall be fabricated by a Resolco or equivalent. Approved fabricator from Resolco CFC & HCFC free heavy density Insul-Phen in 3.75lb/ft³ density., or equivalent 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 diameter (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, galvanized or carbon steel.
- .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 Chlorinated

- polyvinyl chloridematerial, 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 equivalent.
 - .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 Corrolon or RPR Rib-Cor, 3/16" (0.2 mm) corrugated in the circumferential direction or equivalent.
 - .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 equivalent.
 - .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 equivalent. 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 nonfood 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).
 - .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*
 - Or equivalent.

- .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 fiberglass 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 21 01 01. 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 or equivalent.
- .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)	4 (100) and smaller	1 (25)
	105 to 140 (41 to 60)	5 (125) and larger	1-1/2 (40)
	141 to 200 (61 to 93)	All sizes	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.
 .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 or equivalent. 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. GENERAL

1.1 Scope / Summary

- .1 Provide all metering equipment required to measure and trend natural gas consumption by end use.

1.2 Related Sections

- .1 22 09 00 Instrumentation and Control for Plumbing
- .2 26 09 13 – Electrical Power Monitoring

2. Design Requirements / Products

2.1 End Uses to be Monitored

- .1 Provide gas meters for each separate end use, including but not limited to:
 - .1 Facility incoming gas
- .2 Metering Equipment
 - .1 Meters
 - .1 Provide gas meters complete with bypass piping arrangement or other means to remove or isolate for service without interruption to gas flow.
 - .2 Materials shall be compatible with the systems in which they are installed at all potential operating temperatures and pressures.
 - .3 Meters shall provide a pulse output scaled to an appropriate volume. In general, provide a scaled pulse output of 0.01 m³ per pulse unless high consumption would result in pulses too frequent to be reliably captured by the pulse counting equipment.
 - .4 Meters requiring power shall be hard-wired to an emergency power circuit. Battery powered units are not acceptable.
 - .5 Provide meters with readout of totalized volume.
 - .6 Accuracy +/- 1.5% in expected operating flow range.
 - .2 Data logging Equipment
 - .1 Internet Protocol (IP) based data logger complete with:
 - .1 Built-in web server.
 - .2 Capable of operating with a dedicated IP address (to be provided by the Region).
 - .3 Communications Protocols:
 - .1 HTTP/Post capable of pushing data to 3rd party applications/databases.
 - .2 Modbus TCP
 - .4 Built-in real-time and historic graphics accessible with any HTML 5 internet browser (computer, tablet, phone) on the Region's network. Data to be displayed in local time, adjusted for daylight savings time.
 - .5 Real-time clock with battery backup and email alert for battery end of life.
 - .6 Time-Stamp:
 - .1 Represent date and time
 - .2 In UTC time or offset from a specified UTC time
 - .3 Resolution: Minimum 1 second
 - .7 Ability to export all stored trend data to comma separated value (.csv) or Microsoft Excel format for importing into spreadsheets. Time-stamps to be exported as a single field with a numeric (non-text) value in local time.
 - .8 Published application programming interface (API) allowing data to be retrieved from the pulse counter via non-proprietary means, such as JavaScript Object Notation (JSON).
 - .9 Provide minimum 2 spare inputs for future additional meters.
 - .10 Location of spare inputs to be determined by the Region.

- .11 Built-in trending and data storage:
 - .1 3 years of consumption data (m³) at 5 minute intervals for each input with time-stamp.
 - .2 Stored in non-volatile memory.
- .12 Battery/power backup (for pulse counting):
 - .1 Lasting a minimum of 72 hours.
 - .2 Rechargeable.
 - .3 Email alert for battery end of life.
- .13 No special software required to set up data logger or access data.
- .14 Security:
 - .1 Unrestricted access to data and graphics over the Region's network.
 - .2 Password protection for access to setup, changing settings/parameters and deleting data.
- .15 Ability to measure, store and trend the following data complete with timestamp:
 - .1 Totalized consumption (m³)
 - .2 Acceptable product: z3 Controls Inc. NetMeter OMNI or equivalent.
- .3 DATA CABLING
 - .1 Cat 5e or Cat 6 Unshielded Twisted Pair (UTP)
 - .2 Colour: Green

3. Execution

3.1 Provide gas meters for each separate end use, including but not limited to:

- .1 Installation Requirements
 - .2 Meters to be supplied and installed by the mechanical contractor. Meters to be supplied with complete pulse output. Sub Meters by American Meter Co., Itron or Norgas Controls or equivalent are acceptable. Pulse output should be complete with wiring harness. BAS contractor to supply intrinsically safe barrier as required. Manufacturer's technician to be on site for the startup, to be included with the meter supply.
 - .3 Install data logger in a painted, hinged NEMA 1 (or better) enclosure complete with power supply. Label front of enclosure with data logger name, IP address, meter name(s) and load(s) measured.
 - .4 Provide optical isolation/safety devices as required by the local gas utility or other authorities having jurisdiction.
 - .5 All communication and signal cables to be continuous. No splicing is allowed.
 - .6 Affix York Region Property Services Branch Asset ID tag (to be provided by the Region) to data logging unit prior to installation.
 - .7 Data logger and network configuration to be done in consultation with the Region's Property Services Branch.
 - .8 Connect data logging equipment to the Region's IT network.
 - .9 Commission data logger:
 - .1 Ensure latest available firmware version is installed in data logger.
 - .2 Obtain Network information from York Region project manager and program into data logger, including IP address, subnet mask, default gateway, primary and secondary DNS addresses.
 - .3 Set data logger clock to current local time.
 - .4 Set up email alerts as specified and/or requested by the Region's project manager.
 - .5 Set up trend logging as specified and/or requested by the Region's project manager. At minimum, set up trend logging per 2.2.2.1.10 and 2.2.2.1.14 above.
 - .6 Set default homepage to display real-time demand graphs and consumption statistics.
 - .7 Confirm data logger readings correspond to physical meter reading.
 - .8 Calibrate any analog sensors connected to the data logger.
 - .9 Verify data logger information is viewable through a web browser on a device on the Region's network.
 - .10 Complete and submit Gas Meter Installation/Startup Verification Form (23 09 13.01).

- .11 Provide training on data logger software use to Region staff including Facilities Operations and Maintenance and Corporate Energy Services.
- .12 Provide meter manufacturer's calibration certificate(s), installation, operations and maintenance manuals (for meter(s) and data logger) and recommended meter recalibration interval(s).

ADDENDUM ME-1

Gas Sub Meter:

1. Meter to be supplied and installed by the mechanical Subcontractor as shown on the Drawings.
2. Meter to be supplied with complete pulse output.
3. Sub Meter by American Meter, Itron or Norgas or equivalent are acceptable.
4. Pulse output should be complete with wiring harness.
5. BAS Subcontractor to supply intrinsically safe barrier as required.
6. Manufacturer's technician shall be on Site for the startup, to be included with the meter supply.

Water Sub Meter:-

7. Meter shall be supplied and installed by the mechanical Subcontractor as shown on the Drawings.
8. Meter must have Dual pulse contacts (1 for utility and 1 for BAS) or separate meter for BAS with pulse contacts.

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 or equivalent.

.2 Condensing Unit: Carrier 24ANB160A003 or equivalent

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

2. Product Data

The 59TP6A Multipoise Variable- Speed Condensing Gas Furnace shall be a two-stage Performance™ System.

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.
- .3 Height 35" (889mm) cabinet
- .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 the Contract Drawings. Unit shall be used in a refrigeration circuit to match up to a packaged fan coil or coil unit.

3.2 Quality Assurance

1. Unit shall be rated in accordance with the latest edition of ARI Standard 210.
2. Unit shall be certified for capacity and efficiency, and listed in the latest ARI directory.
3. Unit construction shall comply with latest edition of ANSI/ ASHRAE and with NEC.
4. Unit shall be constructed in accordance with UL standards and shall carry the UL label of approval. Unit shall have c-UL approval.
5. Unit cabinet shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hr salt spray test.
6. Air-cooled condenser coils shall 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 shall be shipped as single package only and is stored and handled per unit manufacturer's recommendations.

4. PRODUCTS

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

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 Puron (R-410A), and special features required prior to field start-up.

4.2 Unit Cabinet

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

4.3 Fans

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

4.4 Compressor

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

4.5 Condenser Coil

1. Condenser coil shall be air cooled.
2. Coil shall 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 shall include liquid-line shutoff valve with sweat connections, vapor-line shutoff valve with sweat connections, system charge of Puron (R-410A) refrigerant, and compressor oil.
2. Unit shall be equipped with filter drier for Puron refrigerant.

End of Section

1. PRODUCTS

1.1 MANUFACTURERS

- .1 The following manufacturers are approved for use:
 - 1. Base Bid Tempeff, supplied in Ontario by HTS (905-643-7719) or equivalent. Refer to Section 01 25 00 for Product substitution procedures. All additional costs for any product substitution for all trades associated with any change shall be the responsibility of the Contractor.

1.2 GENERAL DESCRIPTION

- .1 Configuration: Fabricate as detailed on drawings.
- .2 Performance: As shown on schedules.

1.3 UNIT CONSTRUCTION

- .1 Fabricate unit with double wall galvanized panels secured with mechanical fasteners. All access doors shall be sealed with permanently applied bulb-type gasket.
 - 1. Panels and access doors shall be constructed as a 1-inch (25-mm) nominal thick; with injected polyurethane foam insulation. R value shall be 6.5 per inch of wall thickness. The outer panel shall be constructed of G90 galvanized steel. The inner liner shall be constructed of G90 galvanized steel. Manufacturer shall supply test data demonstrating less than L/240 deflection for an unsupported 48x48 panel under 30" W.C pressure. Units that cannot demonstrate this deflection are unacceptable. Outer casing shall be finished with a powder coated industrial paint.
 - 2. Access Doors shall be flush mounted to cabinetry, with minimum of two hinges, locking latch and full size handle assembly.

1.4 SUPPLY / RETURN FANS

- .1 Provide direct-drive plenum fan(s) with ECM motors. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.
- .2 Fan and motor shall be mounted internally on a steel base. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on rubber-in-shear vibration type isolators inside cabinetry.

1.5 ELECTRICAL

- .1 All electrical components shall bear a UL and CSA safety listing.
- .2 Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. All wires shall be number tagged and cross-referenced to the wiring diagram for ease of troubleshooting.
- .3 Air handler manufacturer shall provide and mount a damper controls for standalone operation of the ERV.

1.6 PARTICULATE FILTERS

- .1 Filter section with filter racks and guides with hinged access doors for side loading and removal of filters

- .2 Filter media shall be UL 900 listed, Class I or Class II.
- .3 Flat arrangement with 2", 50mm pleated MERV 8 panel filters.

1.7 ENERGY RECOVERY

- .1 Dual Core™ Energy Recovery
 - .1 Unit shall be equipped with Dual Core™ energy recovery technology. The unit shall be 90% efficient (sensible +-5%) at equal airflow in winter and up to 80% sensible in summer. It shall also provide up to 70% latent recovery in winter mode. Unit shall accomplish this recovery without a defrost cycle that will reduce the effectiveness of the device. Devices employing defrost cycles that bypass the energy recovery device, or reduce the effectiveness are not acceptable. Energy recovery device shall not require frost protection in applications down to -40 degrees. Cores shall be Generation 3, comprised of precisely corrugated high grade aluminum.
 - 2. Switchover damper section shall be comprised of low leakage dampers operated by fast acting electric actuators having damper switching times of 0.75 seconds. Dampers that do not switch within the specified times without objectionable noise are not acceptable.
 - 3. Recovery cycles shall be controlled by internal programmed thermostats measuring both supply and exhaust air, and optimizing performance of both heat recovery and free cooling modes.

3. EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with 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 the 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/ft ²) to ASTM A90. Sheets free of pits, blisters, sliyers, and ungalvanized spot
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 (0.90 oz/ft ² 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	Negative	2	A	6
Rectangular HVAC Return from air outlet to	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, longitudinal seams a
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)				
C_L	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. or equivalent.
- .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 in the Contract Documents.

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 In.(mm)	Duct Metal Thickness		Fitting Metal Thickness	
	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
Flexmaster Type	5	3

- .3 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.
- .4 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.
- .5 Acceptable Manufacturers:
 - .1 Flexmaster
 - .2 Others refer to Section 15010.2.3.
- .4 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.
- .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 Section 01 73 33 *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 Consultant 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 Testing, Adjusting and Balancing agent ("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.
- .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
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 High Transmission Loss 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 23 05 93.
- .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 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 and ASHRAE 70.
- .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 minimum 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 NailorOr equivalent.

2.2 SQUARE CONE DIFFUSERS, FIXED PATTERN

- .1 Manufacturer's Reference: E. H. Price Model SCD or equivalent.
- .2 Type: Square, fixed pattern, stamped, multi-core diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated in the Contract Documents.
- .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 or equivalent.
- .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.

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. The Contractor is fully responsible to provide dampers required for proper balancing of the system.

End of Section

1 General

1.1 GENERAL REQUIREMENTS

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

2 Products

2.1 MANUFACTURERS

- .1 Manufacturer: Schwank Model (UHE –90 -30). Ultra High Efficiency, or equivalent.
- .2 Other manufacturers offering equivalent products with equal or better efficiencies will only be accepted as equivalent (Roberts Gordon LCC & Superior).

2.2 TUBULAR INFRARED HEATERS

- .1 Units: Packaged, partially factory assembled, pre-wired unit consisting of cabinet, burner, heat exchanger, radiant tube, reflector, controls; for natural gas.
- .4 Heat Exchanger: Aluminized tubular steel combustion chamber with aluminized steel tube with aluminum reflector.
- .5 Gas Burner:
 - .1 Gas Burner: Forced draft type with adjustable combustion air supply.
 - .2 Gas valve provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
 - .3 Electronic pilot ignition, with electric spark igniter.
 - .4 Non-corrosive burner air blower with permanently lubricated motor.
- .6 Gas Burner Safety Controls: Thermo-couple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.
- .7 Operating Controls: Line voltage thermostat cycles burner to maintain room temperature setting.
- .8 Each Radiant Tube heater to be controlled by a Schwank Trutemp mean radiant temperature thermostat. Thermostat to be provided by mechanical trade, installed and wired by electrical trade.
- .9 All Radiant Tube Heaters shall be of Ultra High Efficiency.

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 Divisions 21, 22 and 23.
- .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 Contract Documents 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 the Contract 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 in the Contract Documents 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. The General Contractor shall ensure that the necessary number of copies of the returned set are prepared and distributed to the Owner, the Consultant, the General Contractor, the Site, and to relevant 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 the Consultant.
 - .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 Divisions 21, 22 and 23. Obtain the 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 (e.g. 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, the Contractors, and the 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.
 - .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 Work. 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 the 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 the 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 the 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 the Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after the award of the 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.

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 the Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without the Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner Facilities Group in Property Services. Include in the Contract 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 the Consultant, prior to Substantial Performance of the Work, manufacturer's written warranties covering periods longer than two years 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 the 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 Divisions 21, 22 and 23 equipment. Starters and controls shall be Canadian General Electric or equivalent. 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 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.
- .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 Divisions 21, 22 and 23. 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. TelemecaniqueOr equivalent.

2.3 EQUIVALENTS AND ALTERNATIVES

- .1 Please refer to Section 01 25 00 – Product Substitution Procedures.
- .2 The Contract Price shall be based on the product related requirements specified in the Contract Documents.
- .3 Where the Contractor, with the Consultant's approval, 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 the 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 the Contract 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 the Consultant.
- .2 Apply, in writing, to the 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.
- .4 Refer to Section 01 25 00 – Product Substitution Procedures for further requirements.

3 Execution

3.1 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 in the Contract Documents 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 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 the 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 the 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 of the Work.

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 the 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.

3.6 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 the 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 the 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 the 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 Performance of the Work.

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 its Subcontractors as required,
 - .3 Representatives of equipment manufacturers,
 - .4 Representatives of the Consultants,
 - .5 Representatives of the Owner.
- .4 The Contractor and its Subcontractors 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

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 25 01 01

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 Mechanical Divisions 21, 22 and 23 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 Contractor shall ensure that if BAS Subcontractor believes there are conflicts or missing information in the project documents, BAS Subcontractor promptly requests clarification and instruction from the Consultant.

1.3 GENERAL DESCRIPTION

- .1 This document outlines the minimum equipment and performance standards for a completely interoperable Building Automation System (BAS).
- .2 The work shall include design, supply, installation, and commissioning a complete microprocessor based automatic control system to achieve the performance specified in the following Sections.
- .3 The BAS shall be capable of total integration of facility infrastructure systems with user access to all system data, either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet.
- .4 The entire BAS shall be peer-to-peer networked, stand-alone, distributed control in accordance with American National Standards Institute/American Society of Heating, Refrigerating and Air Conditioning Engineers (ANSI/ASHRAE) Standard 135-2004, BACnet – A Data Communication Protocol for Building Automation and Control Networks.
- .5 All labour, material, equipment and software not specifically referred to herein or on the plans, but is required to meet the functional intent, shall be provided without additional cost to the Owner.
- .6 Contractors shall be manufacturers or licensed factory representatives and installers of the manufacturers, specified for the local area in which the Site is located.
- .7 The Contractor shall ensure that BAS Subcontractor provides the necessary engineering, installation, supervision, commissioning and programming for a complete and fully operational system. The Contractor shall provide as many trips to the Site for installation, supervision, and commissioning as are necessary to complete the project to the satisfaction of the Consultant and/or project supervisor.
- .8 The Contractor shall ensure that the controls Subcontractor specifically reads all mechanical and electrical drawings, specifications, and addenda and determine the controls work provided by the mechanical Subcontractor, and the electrical Subcontractor. The controls Subcontractor is expected to have the expertise to coordinate the work of other contractors and to make a completely coordinated Building Automation Control System (BAS) for the mechanical systems.
- .9 The BAS shall be compatible with future control Products for 10 years or more.
- .10 Ensure compliance with all applicable codes and authorities having jurisdiction.
- .11 The system shall be installed by trade certified electricians regularly employed by the controls contractor. The system shall be tested and calibrated by factory certified technicians qualified for this type of work and in the regular employment of the BAS manufacturer or its exclusive factory authorized installing contracting field office representative. The installing Subcontractor shall have a minimum of five years of installation experience with the manufacturer. Supervision, calibration and commissioning of the system shall be by the employees of the factory authorized BAS branch or representative.

2. ACCEPTABLE BAS SUBCONTRACTORS

- .1 The Building Automation System shall be one of the following:
 - .1 Automated Logic
 - .2 Delta Controls Inc.
 - .3 Reliable Controls Corporation.
 - .4 or equivalent.

3. SCOPE

The scope of work under this Section shall include, but not be limited to, the following work:

- .1 Preparation of control shop drawings for review and approval. *See Submittals.*
- .2 Supply and install a network of Building Automation Control System (BAS) panels and field devices. *See Hardware, Software and Field Devices.*
- .3 Supply and install customized graphics software as specified. *See Software.*
- .4 Install, wire and label all BAS control system components. *See Installation.*
- .5 Calibrate and commission the installed control system. *See Commissioning.*
- .6 Provide maintenance manuals and as-built drawings. *See As-Built Documentation.*
- .7 Provide customized training for operations, maintenance and technical staff. *See Training*

4. DRAWINGS AND SUBMISSIONS

Submit four (4) copies of following information to the consultant and/or the project manager for review and approval:

- .1 Control Schematics.
- .2 Detailed sequence of operation for each control schematic or controlled system.
- .3 System Architecture indicating the proposed interconnection and location of all BAS panels, network connections and key peripheral devices (workstations, modems, printers, repeaters, etc.)
- .4 BAS Points List indicating the panel ID, panel location, hardware address, point acronym, point description, field device type, point type (i.e, AO/DO/AI/DI), end device fail position, end device manufacture and model number, and wire tag ID). Terminal identification for all control wiring shall be shown on the shop drawings.
- .5 Wiring diagrams including complete power system, interlocks, control and data communications.
- .6 Hard copy graphical depiction of the application control programs.
- .7 Manufacturers' data / specification sheets for all material supplied.

5. Materials

- .1 All points shall be available to BACnet.
- .2 Points shall be field reconfigurable. No set points shall be hard coded in the programs.
- .3 All controllers shall be loaded to a maximum of 80%. 20% of each of the inputs, outputs and variables shall remain unused to allow for future growth and expandability.
- .4 The system shall consist of all operator interfaces, microprocessor-based controllers, sensors, wells, automatic control valves, control dampers, transducers, and relays, automatic control valves, and damper actuators.
- .5 All equipment, points, etc. shall have common labelling.
- .6 Software shall be completely programmable and capable of all control and mathematical functions.
- .7 All temperature units for BAS and controlled equipment shall be in °C (degrees celcius).
- .8 Operator Activity Tracking - An audit trail report to track system changes, accounting for operator initiated actions, changes made by a particular person or changes made to a specific piece of equipment

- designated time frame, shall be printable and archived for future use. The operator activity tracking shall be in a tamper-proof buffer file.
- .9 Operator workstation interface software shall optimize operator understanding through the use of English language prompting, English language point identification and industry standard PC application software. The software shall provide, as a minimum, the following functionality:
 - a. Real-time graphical viewing and control of environment
 - b. Scheduling and override of building operations
 - c. Collection and analysis of historical data and dynamic data (trend plot)
 - d. Definition and construction of dynamic color graphic displays
 - e. Editing, programming, storage and downloading of global controller databases
 - f. Alarm reporting, routing, messaging, and acknowledgment
 - .10 Provide a graphical user interface, which shall minimize the use of the keyboard through the use of a mouse or a similar pointing device and a "point and click" approach to menu selection.
 - .11 Battery backup: Automatic restart after power failure: Upon restoration of power after an outage, the BAS shall automatically, and without human intervention, update all monitored functions, resume operation based on current synchronized time and status and implement special start-up strategies as required.
 - .12 Refresh rate – The maximum permissible refresh rate is ONE (1) second. The refresh rate is defined as the time it takes the controller central processing unit (CPU) to sample all inputs, calculate all variables, update all timers and proportional integral derivative (PID) controllers, check all schedules, update all trend logs and runtime logs, execute all programs and assign values to all outputs.
 - .13 The HVAC equipment shall be supplied as "Thermostat-Ready". The building automation system shall have direct control of dampers, heating and cooling stages without the requirement of BACnet, Lonworks or any other type of communication interface. Factory installed interlocks, safeties and anti-cycle timers shall be provided as required.
 - .14 Reports shall be generated on demand or via a pre-defined schedule and directed to video displays, printers or hard drive. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - a. A general listing of all or selected points in the network
 - b. List of all points currently in alarm
 - c. List of all points currently in override status
 - d. List of all disabled points
 - e. List of all points currently locked out
 - f. List of user accounts and access levels
 - g. List all weekly schedules
 - h. List of limits and dead-bands
 - i. Excel reports
 - j. System diagnostic reports including a list of BAS panels on line and communicating, and the status of all BAS terminal unit device points
 - k. List of programs
 - .15 Provide a means for the operator to view the communication status of all controllers connected to the system. The status should show whether the controller is communicating or not.
 - .16 Provide a means for the operator to reset the error count for all controllers to zero.
 - .17 Provide a means for the operator to display and change the system configuration. This shall include, but not be limited to, system time, day of the week, date of day light savings set forward/ set back, printer type and port addresses, modem port and speed, etc. Items shall be modified utilizing easy to understand terminology using simple mouse/cursor key movements.
 - .18 Provide a security system that prevents unauthorized use unless the operator is logged on. Access shall be limited to the operator's terminal functions unless the user is logged on.
 - .19 Where possible, utilize Optimized Start features on equipment to reduce hydro demand charges.
 - .20 During the initial design The Region shall supply the controls contractor a range of BACnet addresses the

BAS will run on. The BAS network will run either BACnet over IP or BACnet over MSTP. All BAS points will be network visible so that other BACnet systems can auto discover them. The Contractor shall consult with York Region Project Manager during the development of addresses.

6. Operator's Workstation

- .1 Supply and install all operating software and dynamic system graphics on the Operator's Workstation. Workstation to be supplied by BAS contractor unless stated otherwise by The Region Project Manager.
- .2 Supply licenses for all software required to monitor, configure system, edit graphics, trend storage, (data exchange including Open Database Connectivity (ODBC) if applicable)) without limitations to points.
- .3 Reliable Controls shall include licensing for the following: Mach-Proweb (MPW) controllers which allows any web enabled device to access graphics and adjust set points. Server not required. Built-in controller trend logs are acceptable, server is not required. One MPW is required for the EMS Station located in the mech/elect room. Remote access to the vendor is only possible through a pre-arranged GOTO meeting with operation and maintenance department. Integration of lighting controls into BAS is not required.
- .4 Delta Controls shall include licensing for the following: ORCAweb-Large, Illustrator, ORCAweb, OWS, ODBC, DDE, Historian Large.
- .5 Automated Logic shall include licensing for the following: WEB CTRL, Advanced reports.
- .6 The operator workstation interface software shall be designed to operate on the Windows 7 Professional platform.

7. WAN Access

- .1 Provide necessary interface and cabling to connect the BAS to the YR WAN. Obtain the particular WAN system details from the Consultant or Project Supervisor.
- .2 The Region shall supply the WAN IP address, Gateway and Subnet mask for the BACnet/IP Broadcast Management Device (BBMD) router in the network. The controls contractor will facilitate integration into the Region's existing BAS BACNET network.
- .3 On the network a BACnet IP device that is capable of BBMD will route information from other sites and the operator work station. In addition there shall be a CAT5 wire that is run to the Region's IT switch with a 4' pigtail and connector.

8. Trend Data

- .1 Provide trend logs for every hardware input and output.
- .2 All trends should be accessible via the graphical interface.
- .3 Trends should contain all related variables of a control loop (i.e. setpoint, measured variable and control output) and have the ability to be plotted simultaneously on the same graph. Field Devices Individual trends should provide an appropriate "snapshot" of the variable. Trends should contain a minimum of 5 days worth of trend data.
- .4 Provide trending capabilities at 5 minute intervals that allow the user to easily monitor and preserve records of system activity over a one year period. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard drive for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
- .5 Trending shall be accessible from the graphics screens for each point. Each point shall have its associated trend capability accessible from the graphic via an icon located beside the point name on the graphic page.
- .6 Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual point or predefined groups of at least six points. Provide sufficient capacity to allow for trending a minimum of 100 points at 2000 samples each. Reports should be easily transferable on-line to Microsoft Excel. The Contractor shall provide custom designed spreadsheet reports for use by the Owner to track energy usage and cost, equipment run-times, equipment efficiency, and/or building environmental conditions.
- .7 The operator shall be able to change trend log setup information. This includes information to be trend logged as well as the interval at which the information is to be logged. All points in the system may be

logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics where the point is displayed.

- .8 Trending shall include the ability to track energy management aspects including, but not limited to, the following:
 - a. Daily use
 - b. Monthly use
 - c. Daily Hi and Low
 - d. Monthly Hi and Low
 - e. Demand Limiting and Load Shedding Program
 - f. Run time accumulation for any specified equipment
 - g. After hour use log
- .9 The primary input sensor for all control loops must connect to the same panel containing the control loop output.
- .10 Trend data storage must be in the same panel as the hardware or logical points being trended.

9. Alarms

- .1 The BAS will be configured to provide for remote alarm capabilities.
- .2 Alarms shall be capable of being routed to The Region's IT server so that they can be sent to Operator's email addresses.
- .3 The operator workstation shall provide audible, visual and printed means of alarm indication. The Alarm Dialog box shall always become the Top Dialog box regardless of the application(s) being run at the time (such as a word processor). A printout of all alarms shall be sent to the assigned terminal and port.
- .4 Provide a log of alarm messages. The alarm log shall be archived to the hard drive of the operator workstation. Each entry shall include a point descriptor and address, time and date of alarm occurrence, point value at the time of alarm, time and date of point return to normal condition and time and date of alarm acknowledge.
- .5 The controls Subcontractor shall work with the Region to determine the alarms unless specified otherwise.
- .6 Alarm messages shall be in plain English and shall be user definable on site or via remote communication.

10. Field Devices

- .1 Automatic Control Valves
 - a) Valves used for throttling applications shall have a linear percentage-to-flow characteristic.
 - b) Ball valves are the preferred valve type for zone and HVAC control valves. Globe and butterfly valves shall be used where required to provide the desired pressure drop and CV.
 - c) Automatic Control valves shall be manufactured by Belimo or equivalent.
- .2 Control Valve Actuators
 - a) Size control valve actuators to provide a tight close off against system head pressures and pressure differentials.
 - b) Valve actuators shall accept a 0-10VDC control voltage for all proportional applications.
 - c) Floating point control of valves is not acceptable under any circumstances.
 - d) Heating valves shall spring-return fail open and cooling valves shall spring-return fail closed. Non-spring-return control valves may be used for terminal reheat coils and large HVAC control valves requiring a higher close off pressure.
- .3 Damper Actuators
 - a) Actuators shall be direct coupled for either modulating or two position control. Actuators shall be powered by an overload-proof synchronous motor. Provide 0-10 VDC control voltage for all proportional applications and either line or low voltage actuators for all two position applications.

- b) Damper actuators are to be manufactured by Belimo.
- .4 Automatic Control Dampers
 - a) All automatic control dampers not furnished with packaged equipment shall be supplied by the controls subcontractor and installed by the sheet metal subcontractor (except for VAV Boxes which shall be supplied by the mechanical Subcontractor). All dampers in a mixing application shall be opposed blade. Parallel blade shall be permitted in other applications. Dampers shall be a tight closing, low leakage type with replaceable extruded vinyl seals on all outdoor and exhaust applications.
- .5 Room Sensors/Thermostats
 - a) Office: Temp Display, Set point Display, Set point Adjust, Schedule Override, High and Low Limit on set points.
 - b) All areas except offices: Set point Adjust, Schedule Override, High and Low Limit on set points.
 - c) Mount sensors at a height of 5'-6" unless otherwise indicated.
 - d) Mount thermostats and space sensors as noted on the drawing. Do not mount on outside walls without permission of consultant.
- .6 Current Switches (Digital)
 - a) Provide BAS status for fan and pump motors using a mosfet type digital switch. Acceptable manufactures are ACI Instrumentation, Enercorp Instruments Ltd., Greystone, Veris and Elkor Technologies Inc. or equivalent.
- .7 Pressure Transmitters
 - a) Technical Performance - Solid State design, operating on capacitance principle, with non-interactive fine resolution, zero and span adjustments. End-to-end accuracy +/- 2% of full scale pressure range, including temperature compensation. 4-20mA or 0-5 VDC output.
 - b) Standard of Acceptance – ACI, Enercorp, Greystone, Modus. or equivalent.
- .8 Duct Temperature Sensor
 - a) Probe - Technical Performance – 10 k ohm thermistor sensor encapsulated in a 200mm long, 6mm OD copper or stainless steel probe. Operating range 0-60 degrees C. End-to-end accuracy +/- 0.3 degC. Assembly complete with wiring housing and mounting flange.
 - b) Averaging - Technical Performance - 10 k ohm thermistor constructed of FT6 plenum rated cable or soft copper tubing, incorporating numerous temperature sensors encapsulated at equal distances along the length of the element. The assembly acts as a single sensor reporting the average temperature from all individual sensors. End-to-end accuracy +/- 0.3oC. Assembly complete with wiring housing and mounting flange. Mount in a zig-zag manner to provide continuous coverage of the entire duct cross-sectional area.
- .9 Outdoor Air Temperature Sensor
 - a) Two outdoor air temperature sensors shall be installed and shall be programmed to check each other for accuracy. In the event of sensor failure the sensor deemed to be accurate shall be used to control the systems. The outdoor air sensors shall be located on a north wall if possible and a minimum of three (3) feet from any opening in the building envelope which could affect the sensor readings. The back face of the sensor enclosure shall be insulated to prevent temperature pick up from the building wall.
 - b) Technical Performance, 10 k ohm thermistor -50°C to 50°C in a weatherproof enclosure mounted on north exposure. End accuracy of +/- 0.3 °C over the entire operating range.
- .10 Pipe Temperature Sensor
 - a) Well - Technical Performance - 10k ohm thermistor sensor encapsulated in a 6mm OD, 50mm long probe, with screw fitting for insertion into a standard thermowell. Operating range -10 - +100 oC. End-to-end accuracy +/- 0.3 oC over the entire operating range. Complete with brass thermowell. Use heat transfer paste when mounting the sensor in thermowell. No surface mount strap on temperature sensors shall be used to monitor fluid temperature unless approved by the Consultant.

.11 CO₂ Detector

- a) Technical Performance – Infrared CO₂ monitor c/w 4-20mA or 0-5 VDC output, accuracy of +/- 40 ppm +3% reading.
- b) Standard of Acceptance – ACI-CO₂-D or Telaire duct mount or equivalent..

11. Security System Monitoring to BAS

- .1 Provide digital input from security system.
- .2 When building security armed all outside lighting control shuts off 20 minutes after alarm system armed.
- .3 When building security armed all Air Handling Units's, Exhaust Fans and heating systems shall be changed to unoccupied mode immediately when armed regardless of scheduled times.
- .4 All critical alarms as determined by York Region.

12. Enclosure

The BAS control and power supply cabinets shall conform with the following:

- .1 Panel enclosures shall be a locking type, metal cabinet, with common keying.
- .2 CSA certified 150359 and UL listed E109310.
- .3 16 or 14 gauge steel.
- .4 Slip hinges enabling door removal for easier access and mounting. Door shall be lockable.
- .5 1/4 turn keyed latch standardized to G549 keyset.
- .6 14 or 12 gauge galvanized steel panel on collar studs natural finish.
- .7 Grounding stud on inner cover surface.
- .8 Grounding hole on mounting panel with grounding screw.
- .9 ANSI/ASA61 grey polyester - epoxy textured powder coating inside out.
- .10 3" deep wire duct shall be installed to neatly conceal controller wiring.
- .11 Power supply cabinets shall be provided with a ESA Field Evaluation approval.
- .12 2-100VA 120/24 Transformers Class II UL5085-3.
- .13 Over Current Protection by Circuit Breaker.
- .14 Outlet Receptacle for Service Laptop Power.

13. BAS Database Naming Conventions & Programs

- .1 All BAS programs shall be created in each panel in logical order as determined by the equipment being controlled by each panel on the network.
- .2 All programs and program code is to follow proper coding practices including internal comments to describe the function of the statements and also ensure the source code is formatted in a consistent and logical manner. Programming coding should be kept as simple as possible.
- .3 System Schedules shall be submitted for approval and will include global and local scheduling.
- .4 The Outdoor Air Temperature Program shall be in its own program named OAT PG.
- .5 Network Status Panel Naming Conventions should indicate the building, panel location and panel number. The building name can be abbreviated as necessary to fit in the space.

14. Graphic Display Screens

- .1 All Graphic Display Screens shall have the following common elements and functions regardless of system manufacturer. Every site shall have a graphic display screen for Site Graphic, System Architecture, each air handler, boilers, emergency generator, lighting, exhaust fans, heat reclaim, and for each room controlled by the BAS system.
- .2 All operator accessible points shall be yellow text and all information points shall be blue.
- .3 Trending shall be accessible from the graphics screens for each point. Each point shall have its associated trend capability accessible from the graphic via an icon located beside the point name on the graphic page.

- .4 Appendix A at the end of this document shows examples of typical graphic screens. These are examples only. Graphics shall comply with the following specific screen content. Not all equipment and systems are listed below but the format will be the same for other equipment:
- .5 Graphic Screens General All Screens
 - a) Navigation buttons to each major system in the building which indicate current screen display by a change in button colour
 - b) Background colour shall be black
 - c) Outdoor air temperature shall be displayed on every graphic screen
- .6 Site Graphic
 - a) The York Region Logo on the site or opening graphic screen
 - b) Artist concept or scanned in picture of the front of the building
 - c) Access links to all global schedules or specific screens affecting entire building operation
 - d) Access buttons links to Set Time, Holiday Schedule, Schedule, Alarms, Points on Manual
- .7 System Architecture
 - a) Control panel layout and network architecture
 - b) Indicating BAS panels and panel type(model)
 - c) Panel locations room number text on screen
 - d) Systems controlled by each panel
 - e) Links to points list accessible from each panel
- .8 Architecture Panel Layout (Locations on Floor Plans)
 - a) Locations of each panel on each floor plan level
 - b) Panel types indicated by different icon
 - c) Controls transformers locations
 - d) Main network wiring and sub-network wiring layout
- .9 Floor Plans graphics
 - a) Room numbers accurate as per room signage
 - b) Mechanical rooms locations & signage tags
 - c) Space temperatures for every temperature on each floor in appropriate room
 - d) Space focus pick area for individual room control where applicable shall be yellow text
 - e) Air Handler symbols indicating areas of the floor plan serviced by each air handler by a corresponding colour
 - f) Status of Air Handler by colour change Red for off status, or text indication
 - g) Supply air temperature for each air handler
- .10 Air Handler (AHU) graphic
 - a) Accurate representation of the AHU design
 - b) All associated control points to be displayed
 - c) All points to be monitored for automatic mode and shall be displayed when in Manual mode
 - d) A calculated percentage of fresh air shall be indicated on the AHU graphic
 - e) Operator offset adjustment of the supply air setpoint, adjustable directly from the graphic
 - f) AHU physical location shall be indicated on the graphic
 - g) Weekly occupied time of day schedule for the associated AHU shall be accessible directly from the graphic by selecting an icon
 - h) Weekly student time of day schedule for the associated AHU shall be accessible directly from the graphic by selecting an icon
 - i) Trend logs shall be accessible directly from the graphic by selecting an icon
- .11 Boiler graphic
 - a) Boiler graphic piping layout shall be accurate as per piping layout

- b) All associated control points for the boiler system to be displayed
- c) Operator offset adjustment of the scheduled water setpoint, adjustable directly from the graphic
- d) Lead boiler and boiler stages shall be indicated
- e) Lead pump shall be indicated
- f) Boiler status shall be indicated graphically
- g) Pump status shall be indicated graphically
- h) Calculated scheduled water setpoints to be displayed
- i) Operator offset editable directly from the graphic screen
- j) Weekly time of day schedule for the building occupied schedule shall be accessible directly from the graphic by selecting an icon
- k) Trend logs shall be accessible directly from the graphic by selecting an icon

.12 Exhaust fans graphic

- a) Exhaust fans control shall be editable directly from the graphic
- b) Exhaust fan status shall be indicated in text and a change in the exhaust fan icon
- c) Exhaust fan physical location shall be indicated on the graphic
- d) Area of the building being exhausted shall be indicated on the graphic

15. Installation

- .1 All wiring line and low voltage shall be installed in EMT conduit unless specifically specified otherwise.
- .2 All wiring shall be in accordance with the Ontario Electrical Code and any applicable local codes. All BAS wiring shall be installed in conduit unless otherwise allowed by the Ontario Electrical Code or applicable local codes. Where BAS plenum-rated cable wiring is allowed, it shall be run parallel to, or at right angles to, the structure, properly supported and installed in a neat and workmanlike manner. BAS wiring that runs in exposed ceiling spaces (eg garages, mechanical rooms) shall be installed in conduit.
- .3 In accessible ceilings, wiring from BAS controllers to sensors and actuators, control system network and low voltage wiring only may be installed with yellow jacket Low Voltage Thermostat cable. Where the ceiling is used as a return air plenum install plenum rated yellow jacket cable instead of LVT.
- .4 BX or flex conduit may only be used for the final (approximately one meter) run to controls devices, where the controls equipment is mounted on vibrating machinery.
- .5 Install EMT and cable at right angles to building lines, securely fastened, and in accordance with the standards set out in all electrical Specifications Sections..
- .6 No wire smaller than 18 gauge is to be used on the project except for: wiring between terminal computer devices, wire in standard communication cables, such as printers and short haul modems, wire used in communication networks, i.e. any cable transferring digital data, using twisted shielded pairs.
- .7 All field wiring including sensor wiring and wiring from panels to devices shall be continuous. The use of wire connectors, wire nuts or splicing is not allowed.
- .8 Provide wells for all specified temperature sensors in hydronic piping system. Strap-on sensors may be only be used where a well installation is not possible. Obtain approval of the Consultant for the use of strap-on sensors.
- .9 Power for control system shall not be obtained by tapping into miscellaneous circuits that could be inadvertently be switched off.
- .10 Mount transformers and other peripheral equipment in panels located in serviceable areas. Provide line side breakers/fuses for all transformers.
- .11 All 120 VAC power for any controls equipment shall be from dedicated circuits. Provide a breaker lock for each breaker used to supply the control system. Update the panel circuit directory.
- .12 The controller may be powered from the equipment that it is directly controlling (i.e. heat pump, roof-top unit) only if the controller controls no other equipment and the power supply to the controller remains energized independently of unit operation or status.
- .13 All BAS control wiring shall be yellow jacket for identification purpose.

- .14 The breaker or power isolation location shall be clearly marked on the inside door of each BAS panel enclosure.
- .15 Wiring in ceiling spaces to be installed clear of ceiling tiles and lights to allow access and removal of tiles and lights.
- .16 The Contractor shall prepare a wiring mock-up of a typical system/device/main panel to demonstrate quality and workmanship for approval by the Region. This approved mock-up quality shall be maintained throughout the entire installation. System requiring mock-up to be discussed with the Region's Project Manager.
- .17 All wiring shall be routed orthogonally and drops shall have additional wiring coiled in ceilings to facilitate future sensor relocation.
- .18 Wiring in ceiling spaces to be secured/tied every 48" minimum.
- .19 Surge suppression shall comply, as a minimum, with the manufacturer's requirements.
- .20 All equipment including controllers shall be grounded.
- .21 All end-of-wire connectors shall be certified.
- .22 All components shall be labelled and detailed in manuals.
- .23 All wiring systems shall be colour coded to simplify maintenance.
- .24 All equipment shall be located for ease of service access.
- .25 Contractor shall maintain a list of deficiencies when close to completion, and shall update this list on a regular basis for review by the Owner's representative.
- .26 If the project is a retrofit of an existing system:
 - a) Contractor shall remove all old redundant wiring following system verification
 - b) Re-use of existing wiring is not allowed. Run continuous new wiring
 - c) Re-use of components (eg enclosures, transformers) is not allowed unless approved by the Region's Project Manager

16. Equipment Location

- .1 All distributed equipment such as VAV boxes, Roof top units, unit ventilators, fan coil units, etc. that utilize dedicated BAS controllers, shall have locally mounted controllers, in accessible locations within the building envelope. All locally mounted controllers shall be installed in enclosures suitable for that location. BAS controllers for mechanical equipment other than those listed above shall be mounted in mechanical rooms as noted below, unless specifically approved by the Consultant for this project.
- .2 All other BAS controllers, and interface devices that require regular inspection or that serve multiple HVAC systems shall be located in mechanical rooms, or in pre-approved storage rooms, or janitor closets.
- .3 No BAS panel shall be located inside the rooftop fan enclosure under any circumstances. All BAS panels shall be located within the building envelope, and shall be enclosed in a metal locking enclosure, as specified in 16.4.
- .4 All equipment located in mechanical rooms, storage rooms or janitor closets shall be installed in metal cabinets with hinged, lockable covers.
- .5 Transformers or power supplies shall not be located in ceiling spaces unless approved by the engineer for terminal control valves, actuators or zone controllers. When transformers are installed above ceilings, transformers shall be installed in metal enclosures, and the location shall be clearly labeled on the t-bar ceiling to indicate power transformer location.
- .6 A 120 VAC duplex receptacle for laptop power shall be provided if the cabinet is located further than 5' laterally from the nearest outlet.

17. Identification and Labelling Equipment

- .1 All panels must have a lamacoid tag (min. 3"x1") affixed to the front face indicating panel designation and function (i.e. "BAS Panel 1" or "Relay Panel 3").
- .2 All field sensors or devices must have a lamacoid tag (min. 3"x1") attached with tie-wrap or adhesive indicating the point software name and hardware address (i.e. AHU1_MAT, 2.IP4).

- .3 Room sensors and other sensors in finished areas will require a device tag.
- .4 All devices within a field enclosure will be identified via a label or tag.
- .5 All BAS panel power sources must be identified by an adhesive label indicating the source power panel designation and circuit number on the outside of the enclosure door (i.e. "120vac fed from LP-2A cct #1).
- .6 All field equipment panels fed from more than one power source must have a warning label on the front cover.
- .7 All wires will be identified with self-adhesive wire labels or clip-on plastic wire markers at both ends.
- .8 All rotating equipment controlled by the BAS will have a tag or label affixed indicating that the equipment may start without warning.
- .9 All BAS panels will have a points list sheet (within a plastic sleeve) attached to the inside door. The points list will identify the following for each point: Panel number, panel location, hardware address, software name, point description, field device type, point type (i.e. AI or DO), device fail position, device manufacturer and model number or reference and wire tag reference.
- .10 Where required, field panels will have wiring diagrams attached to the inside door.
- .11 Provide new or modify existing equipment wiring diagrams (i.e. boilers, chillers, etc.) wherever the BAS interfaces to other equipment.

18. Commissioning

- .1 Perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning.
- .2 Upon completion of the performance tests, repeat these tests, point-by-point in the presence of the Owner's representative, as required. Properly schedule these tests so that testing is completed by the time directed by the Owner's representative.
- .3 Confirm and demonstrate to the Consultant and the Owner's agent that all systems are programmed and operating correctly. When project is complete the contract shall allow sufficient programming time in order to customize the sequences to meet operational needs, fine tuning of the system and other duties as required. York Region will determine the schedule.
- .4 Submit a four (4) copies of the system commissioning report to the Consultant for review and approval.
- .5 Each analogue inputs (i.e. temperatures, pressure, etc.) shall be verified with an approved calibration device. All actual temperature readings should be with +/- 1C of the readings observed at the workstation.
- .6 Each analogue output shall be verified by manually commanding the output channel from the operator workstation to two or more positions within the 0-100% range and verifying the actual position of the actuator or device. All devices shall operate over their entire 0-100% range from a minimum control range of 10-90%.
- .7 Digital outputs shall be verified by witnessing the actual start/stop operation of the equipment under control.
- .8 Digital inputs shall be verified by observing the status of the input point as the equipment is manually cycled on and off.
- .9 Record all out-of-season or unverified points in the commissioning report as "uncommissioned".
- .10 The BAS field panel power source shall be toggled on and off to ensure reboot functionality and power down memory retention of all parameters. During the power down test, all connected system components should go to their fail-safe state.
- .11 All trends should be reviewed to ensure that setpoints are being maintained and excessive cycling of equipment is not occurring.
- .12 Control loop tuning parameters can be verified by applying a change to the current setpoint and observing the resulting trend log. Setpoint should be reached in a "reasonable" period of time without excessive cycling or hunting of the controlled device.

19. Training

- .1 Once 5 consecutive Days of alarm-free operation are complete and documented, operator training may begin.
- .2 Provide 1 day of instruction to the Owner's designated personnel on the operation of the BAS and describe its intended use with respect to the programmed functions. Operator orientation of the BAS shall include,

but not be limited to, the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the system's operation.

20. Warranty

- .1 Warranty all components supplied under this contract for a period of two years in accordance with Article A-15 of the Agreement Between Owner and Contractor. Replace all controls equipment that fails during this period without cost to the owner.
- .2 All controllers shall have a 5 year manufacturer's warranty.

21. As-Built Documentation

- .1 Within two weeks following substantial completion of the project, update the original submittal documents to reflect the "As Built" conditions of the project and submit four copies as required by the consultant and/or the Project Manager.
- .2 Provide a separate laminated copy of the control drawings for mounting in the mechanical room or in the controls panels.
- .3 Provide final point lists, shop drawings and all installed equipment data and operations sheets.
- .4 Submit diskettes/CD's (including back-up diskettes/CD's) containing up to date copies of the programs in each controller. Provide original program disks and documentation proving registration for all software programs provided as a part of this contract including: the BAS operator interface software, and the BAS graphics (bitmap files). Provide one set of original disks for every computer supplied under this Contract or that the software has been loaded onto.
- .5 Submit (4) printed copies of the final programs that include all point definitions, weekly and annual schedule setting, controller setpoints and tuning parameters, and documented programmed sequences of operation.

22. Control Points and Points List

- .1 A typical points list for system control and monitoring is shown in Appendix B and shall be used as a guide for system design.
- .2 This points list is not intended to be complete. It is intended to be a typical list to capture all foreseeable equipment types. Project specific points list must be created on a project-by-project basis by the BAS contractor and shall be reviewed by York Region.
- .3 York Region staff shall be consulted to develop the sequence of operations. York Region will provide the BACnet address range for each building.
- .4 All control points shall have built in time delays to prevent short cycling.
- .5 Point Naming conventions shall be submitted for review by York Region Project team. Names may be changed to comply with the Regions naming conventions.

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 25 01 01 General Requirements.

1.2 SECTION INCLUDES

- .1 Sequence of operation:
 - .1 Furnace & DX Condensing unit
 - .2 ERV
 - .3 Exhaust Fan IT Room
 - .4 DE stratification Fans
 - .5 Domestic Hot Water Recirculation Pump
 - .6 CO/NOX Ventilation System for Truck Bay & Ambulance Bay.

.1 Furnace & Condensing Unit

.1 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 furnace will operated by BAS to maintain room temperature at set point. During the summer season the DX condensing unit will be energized to provide cooling to meet the room temperature set point. During winter season BAS enable/ disable stage 1 and stage 2 heating to maintain room temperature at set point. BAS to operate the supply fan at low speed or high speed determined by outdoor temperature, room temperature and room temperature set point.
- .3 BAS will enable/disable the furnace and will monitor the status to generate an alarm if the furnace fails to operate when commanded on.

.2 ERV

- .1 ERV will be operated through BAS based on time of day schedule. BAS to map all the occupancy sensor status from lighting control system through BACnet. Building occupancy will be determined by the occupancy sensor status from lighting control system.
- .2 When building is unoccupied, ERV to be off and furnace to be on to maintain unoccupied set point.
- .3 When building is occupied, ERV to be on with furnace to maintain room temperature set point. ERV to run at low speed when the furnace is run at low speed. When CO₂ concentration is above set point then ERV to run at high speed. When furnace is running at high speed, ERV to be run at high speed to maintain negative room pressure in Washrooms and locker room.
- .4 Normally the unit will operate on low speed and upon sensing higher CO₂ concentrations (CO₂ set point to be determined). It will run on high speed.
- .5 The Contractor shall ensure that the BAS Subcontractor to install insulated parallel blade dampers in the intake and exhaust duct of the ERV, BAS to operate both these dampers with the enabling and disabling of the ERV. These dampers are to be in closed position during the time the ERV is not in operation. BAS to generate an alarm if the ERV fails to operate when commanded on.

.3 AC unit IT Room (AC-1)

The AC unit will be standalone control by AC unit Manufacturer. BAS to monitor the room temperature and status of AC-1 through current sensor. BAS to generate alarm if the AC-1 does not operate when commanded on.

.4 De-stratification Fans in Apparatus Bay

These fan will be operated through local speed controller installed in the apparatus bay.

.5 Domestic Hot Water re-circulation pump

BAS will operate the pump based on occupancy determined by security system. Aquastat at the pump will operate the pump to maintain the water temperature at set point. BAS will monitor the pump status through current sensor. BAS will generate an alarm if the pump falls when commanded on.

.6 CO/NOX Ventilation

The exhaust fan 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 to generate an audible and visible alarm. The CO/NOX Set point will be determined during system start up.

End of Section

1. GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to General Requirements, Division 1 and Instructions to Bidders.

1.2 REFERENCES

- .1 Refer to and be governed by the conditions and requirements of the "GENERAL CONDITIONS OF STIPULATED PRICE CONTRACT", Instructions to Bidders and "Division 1 General Requirements" of the specifications.

1.3 APPLICATION

- .1 This Section applies to and is an integral part of all succeeding Sections of this Division of the specification.

1.4 DEFINITIONS

- .1 The following are definitions of words found in Sections of this Specification and on associated drawings:
- .2 "Concealed" - hidden from normal sight in furred spaces, shafts, crawl spaces, ceiling spaces, walls and partitions;
- .3 "Exposed" - all work normally visible to building occupants;
- .4 "Provide" (and tenses of "Provide") - supply, install and connect complete.
- .5 "Install" (and tenses of "install") - install, and connect complete;
- .6 "Supply" - Supply only.
- .7 "Work" - all equipment, permits, materials and labour to provide a complete electrical installation as required and detailed in Drawings and Specification.
- .8 "Authorities" or "Authorities Having Jurisdiction" - any and all current laws and/or by-laws of any federal, provincial or local authorized agencies having jurisdiction over the sum total or parts of the work including, but not restricted to the Municipal Planning and Building Department, Municipal Fire Department, Labour Canada, The Provincial Fire Marshall, The Local Hydro Supply Authority, The Ontario Building Code, The Workplace Safety and Insurance Act, Municipal Public Works Department, the Canadian Electrical Code with Ontario Supplement, hereinafter referred to as the "Code", the Electrical Safety Authority and all Inspection Bulletins.
- .9 "Drawings and Specifications" - "the Contract Drawings and Specifications".
- .10 "Consultant" shall mean the firm of REGAL ENGINEERING, or other person authorized to act on their behalf.

1.5 WORK INCLUDED

- .1 The work shall include all labour, materials, equipment, permits, inspections and tools required for a complete and working installation as described but not necessarily limited to items, in the following sections:

SECTION 26 00 00	Electrical General Requirements
SECTION 26 05 53	Receptacle and Circuit Labelling
SECTION 26 09 13	Electrical Power Monitoring
SECTION 26 10 00	Electrical Basic Materials and Methods
SECTION 26 30 00	Electrical Service and Distribution
SECTION 26 30 10	Power Generators
SECTION 26 30 20	Low voltage Bypass / Isolation - ATS
SECTION 26 50 00	Lighting System

SECTION 26 60 00	Digital Occupancy Sensors and Lighting Control System
SECTION 26 70 00	Fire Alarm System
SECTION 27 00 00	Telecommunication Raceway System
SECTION 28 00 00	Security System
SECTION 29 00 00	EMS Shore Cord Assembly Details

1.6 SEISMIC RESTRAINTS

- .1 Include all costs related to provisions of seismic restraints and equipment necessary for electrical systems and equipment in the Contract Price. Costs shall include for the design of structural elements (by a Professional Engineer) of the seismic restraints for all electrical equipment included in this Contract.

1.7 SCHEDULING OF PRODUCT DELIVERY

- .1 Every effort must be made to ensure delivery of all materials and products in the Contract Documents on time. At commencement of Contract, prepare schedule of order dates for items requiring long delivery periods.

1.8 EXAMINATION OF SITE

- .1 Prior to submitting a tender carefully examine conditions at the Site, which may or will affect the work. Refer to and examine all Contract Documents, including room finish schedules to determine finished, partially finished and unfinished areas of the building.
- .2 Ensure that materials and equipment are delivered to the Site at the proper time and in such assemblies and sizes so as to enter into the building and to be moved into the spaces where they are to be located without difficulty. Be responsible for any cutting and patching involved in getting assemblies into place.

1.9 QUALITY ASSURANCE:

- .1 General Codes and Standards:
 1. Comply with the Ontario Building Code and Canada Labour Code, Part 4.
 2. Where provisions of pertinent codes or local by-laws conflict with these Specifications and Drawings or each other, comply with the most stringent provisions.
 3. Operating voltages shall comply with CAN3-C235-83.
 4. Ground system shall comply with CSA Standard C22.1.
 5. Abbreviations for electrical terms: to CSA Z85-1983
- .2 Provide new materials bearing certification marks or labels acceptable under Ontario Electrical Safety Code.
 1. Equipment must bear, on manufacturer's label, certification mark or label acceptable under Electrical Safety Authority.
- .3 Provide units from the same manufacturer where two or more units of same class or type of equipment are required.
- .4 Manufacturer's names are stated in this Specification to establish a definite basis for tender submission and to clearly describe the quality of product that is desired for the work.
- .5 Standard Specifications
 - .1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all products provided comply with latest issue of applicable Standard Specifications issued by authorities having jurisdiction, but such Standard Specifications shall not be applied to decrease the quality of workmanship, products and services required by the Contract Documents
- .6 Electrical Codes and Permits:
 - .1 The work shall be tendered on and shall be carried out in accordance with

- these Drawings and Specifications and shall comply with the essential requirements of the latest editions of the Canadian Electrical Code C. 22.1 and the Electrical Safety Code (together with applicable bulletins issued by the Inspection Department of Electrical Safety Authority). In no instance, however, shall the standards established by the Drawings and Specifications be reduced by any of the codes referred to above. In the event of conflicting requirements, the codes shall take precedence over these Contract Documents and the Consultant's decision shall be final.
- .2 Arrange for and obtain all necessary permits, inspection and approvals from authorities having jurisdiction, and also pay all applicable fees. The Contractor shall conform to all Municipal Codes and By-laws which affect the work.
 - .3 Applicable Codes
 - .1 Ontario Electrical Safety Code
 - .2 Canadian Electrical Code with applicable regional amendments
 - .3 Ontario Building Code
 - .4 National Building Code
 - .5 Ontario Fire Code
 - .6 National Fire Code and Fire Commissioner Canada requirements
 - .7 Canadian Standards Association
 - .8 Underwriter's Laboratories of Canada.
 - .9 Canadian Underwriters Association
 - .10 Electrical Inspection Department of Ontario Hydro.
 - .4 Before starting any work, submit the required number of copies of Drawings and Specifications to the Electrical Safety Authority and the local authority for approval and comments. Comply with any changes requested as part of the Contract, but notify the Consultant immediately of such changes for proper processing of these requirements. Prepare and furnish any additional Drawings, details or information as may be required by the Engineer.
 - .5 On or before the completion of this Contract, obtain at Contractor's own expense, the necessary certificate of inspection from the Inspection Branch of the Electrical Safety Authority of Ontario and forward same to the Consultant. Furnish necessary certificates as evidence that work installed conforms to laws and regulations of authorities having jurisdiction.
 - .6 Equipment and material must be acceptable to Electrical Safety Authority.
 - .7 Where materials are specified which require special inspection and approval, obtain such approval for the particular installation with the co-operation of the material supplier.
 - .8 Supply and install warning signs, nameplates and glass covered Single Line Diagrams as required by Electrical Safety Authority.
 - .9 Submit required documents and shop drawings to authorities having jurisdiction in order to obtain approval for the Work. Copies of Contract Drawings and Specifications may be used for this purpose.

1.10 REQUIREMENTS OF DRAWINGS:

- .1 Contract:
 - .1 The Drawings for electrical work are essentially performance drawings, partly schematic, intended to convey the scope of work and extent of work. They only indicate general arrangement and approximate location of apparatus, fixtures and general typical sizes and locations of equipment and connections. The Drawings do not intend to show architectural, structural or mechanical details.
 - .2 Do not scale Drawings, but obtain information involving accurate dimensions to structure from those shown on Architectural and Structural Drawings, or by site measurements of existing areas. Follow the Electrical Drawings in laying out the work but consult general Construction Drawings as well as detail Drawings to become familiar with all conditions affecting the work, and verify spaces in which the

- work will be installed and structures to which it will be attached.
- .3 Make, at no additional cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (runs around beams, columns, etc.). Alter, at no additional cost, the location of materials and/or equipment up to 3m, or as directed by the Consultant, provided that the changes are made before installation and do not necessitate additional material or labour.
 - .4 Leave space clear and install work to accommodate future materials and/or equipment as indicated in the Contract Documents and to accommodate equipment and/or material supplied by other trades. Verify all equipment sizes in relation to space allowed and check all clearances.
 - .5 Confirm on the Site, the exact location and mounting elevation of equipment and fixtures as related to Architectural or Structural details. Confirm location of outlets and/or connection points for equipment supplied by other trades.

1.11 SHOP DRAWINGS:

- .1 Pay careful attention to all shop drawings and review comments and ensure that all requirements are fully complied with.
- .2 Submit for review, manufacturer's or vendor's drawings for all products being furnished except cable (up to 1000V), wire and conduit. Include rating, performance, specification sheets, descriptive literature, schematic and wiring diagrams, dimensional layouts and weights of components as well as complete assembly.
- .3 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences. Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.
- .4 Submit for review, properly identified shop drawings showing in detail the design and construction of all equipment and materials as requested in sections of the specification governed by this Section.
- .5 Identify the equipment by system name and number, e.g. Fire Alarm Control Panel, Emergency Lighting Fixture "type I", etc.
- .6 Obtain and comply with the manufacturer's installation instructions.
- .7 Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS", stamp each copy with name of Contractor, date each copy with the submittal date, and sign each copy. Shop drawings which are received and are not endorsed, dated and signed will be returned for re-submittal.
- .8 The Consultant will stamp shop drawings as follows:
 - .1 Drawing: Reviewed ()
 - .2 Reviewed as Modified ()
 - .3 Revise and Resubmit ()
 - .4 Not Reviewed ()
- .9 If "REVIEWED" is checked-off, the shop drawing is satisfactory. If "REVIEWED AS MODIFIED" is checked-off, the shop drawing is satisfactory subject to requirements of remarks put on shop drawing copies. If "REVISE AND RE-SUBMIT" is checked-off, the shop drawing is entirely unsatisfactory and must be revised in accordance with comments written on shop drawing copies and resubmitted. If "NOT REVIEWED" is checked-off, the shop drawing is in error of submission, not applicable for this project.
- .10 This review by the Consultant is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of 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 co-ordination of the work as well as compliance with

- codes and inspection authorities such as C.S.A., etc.
- .11 Coordinate work of this Division such that items will properly interface with work of other Divisions.
 - .12 Architectural Drawings, or in the absence of Architectural Drawings, Mechanical Drawings govern all locations.
 - .13 Coordinate work of this Division with Division 7 to ensure that damage does not occur to the fireproofing work of Division 7.

1.12 SUBSTITUTIONS

- .1 Refer to 01 25 00.t.

1.13 DIMENSIONS AND QUANTITIES

- .1 Dimensions shown on Drawings are approximate. Verify dimensions by reference to shop drawings and field measurement.
- .2 Quantities or lengths indicated in Contract Documents are approximate only and shall not be held to gauge or limit the Work.
- .3 Make necessary changes or additions to routing of conduit, cables, cable trays, and similar items to accommodate structural, mechanical and architectural conditions. Where raceways are shown diagrammatically run them parallel to building column lines.

1.14 EQUIPMENT LOCATIONS

- .1 Devices, fixtures and outlets may be relocated, prior to installation, from the location shown on the Contract Drawings, to a maximum distance of 3 m without adjustment to Contract price.
- .2 Switch, control device and outlet locations are shown diagrammatically.

1.15 WORKING DRAWINGS AND DOCUMENTS

- .1 Where the word "HOLD" appears on Drawings and other Contract Documents, the Work is included in the Contract. Execute such Work only after verification of dimensions and materials and obtaining Consultant's written permission to proceed.
- .2 Contractor may be required to prepare working detail drawings supplementary to the contract drawings, when deemed necessary by the Consultant, for all areas where a multiplicity of materials and or apparatus occur, or where work due to architectural and structural considerations involves special study and treatment. Such drawings may be prepared jointly by all trades affected, or by the one (1) trade most affected with due regard for and approval of the other trades, all as the Consultant will direct in each instance. Such drawings must be reviewed by the Consultant before the affected work is installed.
- .3 Carry out all alterations in the arrangement of work which has been installed without proper study and approval by the Consultant, even if in accordance with the Contract Documents, in order to make such work come within the finished lines of walls, floors and ceilings, or to allow the installation of other work, without additional cost. In addition, make any alterations necessary in other work required by such alterations, without additional cost.

1.16 INSTALLATION DRAWINGS

- .1 Prepare installation drawings for equipment, based upon approved Vendor drawings, to check required Code clearances, raceway, busway and cable entries, sizing of housekeeping pads and structure openings. Submit installation drawings to the Consultant for review.

1.17 "AS BUILT" RECORD DRAWINGS

- .1 (Refer to and comply with the requirements of Division 1) Maintain a set of Contract Drawings on site and record all deviations from the Contract Documents. As a mandatory requirement, recording must be done on the same day deviation is made. Be responsible for full compliance with this requirement.
- .2 Mark locations of feeder conduits, junction and terminal boxes and ducts or conduits run underground either below the building or outside the building.
- .3 Where conduit and wiring are underground or underfloor, furnish field dimension with respect to building column lines and inverts with respect to finished floor levels or grades.
- .4 Record deviations from branch circuit numbers shown on Drawings.
- .5 Prepare diagrams of interconnecting wiring between items of equipment including equipment supplied by Owner and under other Specification Sections.
- .6 Upon completion of Contract Work, prior to Substantial Performance inspection and after final review with Consultants, Contractor shall neatly transfer recorded information and make final As-Built submission to the Consultant in the following form:
 - One (1) set of clean, legible prints.
 - Updated ACAD R2012 drawings.The submission will be reviewed by the Consultant. Any comments shall be addressed and resubmitted until the submission is in a form acceptable to the Consultant.

1.18 TEST REPORTS

- .1 For each check and test performed, prepare and submit a Test Report, signed by the Test engineer, and where witnessed, by the Consultant.
- .2 Include record of all tests performed, methods of calculation, date and time of test, ambient conditions, names of testing company, test engineer, witnesses, also calibration record of all test instruments used together with manufacturers name, serial number and model number.
- .3 Include calibration record, percentage error and applicable correction factors.
- .4 Submit a Certified Test Report from each manufacturer, signed by the certifying inspector, confirming correct installation and operation of each product and part of Work. Include name of certifying inspector, date and times of inspection, ambient conditions.

1.19 OPERATING AND MAINTENANCE MANUALS

- .1 Refer to and comply with Division 1 and related Sections.

1.12 FIRE BARRIERS

- .1 Where electrical material or devices pass through fire rated separations, make penetrations and provide fire barrier seals with a fire resistance rating equivalent to the rating of the separation.
- .2 Prior to installation, submit for review to the Consultant, proposed fire barrier seal materials, method of installation and ULC system number.
- .3 Acceptable Manufacturers:
 - .1 A/D Fire Protection Systems
 - .2 Dow Corning
 - .3 Fire Stop Systems
 - .4 IPC Flamesafe Firestop
 - .5 Nelson Electric
 - .6 3M
 - .7 Tremco
 - .8 or equivalent

1.21 MISCELLANEOUS METAL FABRICATIONS

- .1 Provide miscellaneous structural supports, platforms, braces, brackets and preformed channel struts necessary for suspension, attachment or support of electrical equipment in accordance with Section 05 50 00. All supports, platforms, brackets and channel struts shall be made of steel material.

1.22 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

- .1 Prepare and submit to the Consultant for review and forwarding to the appropriate sub-trade, drawings indicating all required sleeves. Such drawings shall be completely and accurately dimensioned and shall relate sleeves, recesses, and formed openings to suitable grid lines and elevation datum. Begin to prepare such drawings immediately upon notification of acceptance of tender and award of contract. Make all modifications to locations as directed by Consultant at no extra cost to contract.

1.23 METALS

- .1 Steel construction required solely for the work of electrical trades and not shown on architectural or structural Drawings shall be provided by the Contractor in accordance with applicable code requirements.

1.24 FLASHING

- .1 Flash electrical parts passing through or built into a roof, an outside wall, or a waterproof floor.
- .2 Provide 8 pound sheet lead flashing for cast iron or wrought iron sleeve passing through roof.
- .3 Flashing shall suit roof angle and shall extend minimum 457mm (18") on all sides; leave flashing as directed by the Contractor to build into roofing, rendering a watertight connection.
- .4 Provide counter flashing on ducts and conduits passing through roofs to fit over flashing or curbs.
- .5 Provide sleeves passing through outside walls with lead or copper flashing as directed in the Contract Documents.

1.25 WORKMANSHIP

- .1 Install equipment, ductwork, conduit and cables to best suit space, to present a neat appearance and to function properly to the satisfaction of the Consultant.
- .2 Install equipment and apparatus requiring maintenance, adjustment or eventual replacement with due allowance therefore.
- .3 Include in the work all requirements of manufacturers shown on the shop drawings and manufacturers installation instructions.
- .4 Replace work unsatisfactory to the Consultant without extra cost.
- .5 Protect from damage all equipment delivered to the Site and during installation. Any damage or marking of finished surfaces shall be made good to the satisfaction of the Consultant.

1.26 GUARANTEE - WARRANTY

- .1 Guarantee and warranty requirements of the Contract shall apply except for incandescent lamps which shall be guaranteed for a period of ninety days after acceptance by the Owner.
- .2 In addition to the guarantee covered by the General Conditions, all equipment installed under this Contract shall receive emergency service for the full guarantee period, at no charge to the Owner.

1.27 OWNER RIGHT TO RELOCATE ELECTRICAL ITEMS

- .1 The Owner reserves the right to relocate electrical items (light fixtures) during construction,

- but prior to installation, without cost, assuming that the relocation per item does not exceed 3 m (10'-0") from the original location. No credits shall be anticipated where relocation per item of up to and including 3m reduces materials, products and labour.
- .2 Should relocations per item exceed 3m from the original location the Contract Price will be adjusted in accordance with the requirements of the Contract Documents.
 - .3 Necessary changes, due to lack of co-ordination, and as required and when approved by the Consultant, shall be made at no additional cost, to accommodate structural and building conditions. The location of pipes and other equipment shall be altered without charge to the Owner, if approved by the Consultant, provided the change is made before installation.

1.28 OPERATING AND MAINTENANCE INSTRUCTION MANUALS

- .1 Refer to Division 1.
- .2 Each copy of the manual shall include:
 - .1 A set of as-built prints;
 - .2 Letters of Owner's Instructions;
 - .3 Final Electrical Safety Authority Certificate of Inspection;
 - .4 Verification Certificates for all systems as specified hereinafter;
 - .5 A copy of "reviewed" shop drawings;
 - .6 Complete explanation of operation principles and sequences;
 - .7 Complete part lists with numbers;
 - .8 Recommended maintenance practices and precautions;
 - .9 Parts manual and repair manuals
 - .10 Complete wiring and connections diagrams;
 - .11 Certificates of guarantee;
- .3 Ensure that operating and maintenance instructions are specific and apply to the models and types of equipment provided.

1.29 SYSTEM ACCEPTANCE

- .1 Submit original copies of letters from the manufacturers of all systems indicating that their technical representatives have inspected and tested the respective systems and are satisfied with the method of installation, connection and operation.
- .2 These letters shall state the names of persons present at testing, the methods used, and a list of functions performed with location and room numbers where applicable.
- .3 Submit such letters for the following:
 - Emergency lighting system testing
 - Fire Alarm System Verification

1.30 CLEANING

- .1 Before energizing any systems, inspect and clean the inside of panel boards, switchgear, and cabinets to ensure that they are completely free from dust and debris.
- .2 Clean all polished, painted and plated work bright. Clean all lighting fixtures.
- .3 Remove all debris, surplus material and all tools
- .4 Carry out additional cleaning operating of systems as specified in other sections of this Division.

1.31 PAINTING WORK SUPPLIED UNDER DIVISIONS 26, 26, 27, 28 AND 29

- .1 Touch up minor chips or damage to electrical equipment, installed in this Division, with standard, factory supplied, enamel finish.
- .2 Colour code, as specified herein, outlet boxes, pull boxes, junction boxes by applying a small dab of paint to inside of each item during installation.
- .3 Colour code, as specified herein, all exposed ducts, conduits, outlet boxes, and similar

items by applying a 25 mm (1") wide band of paint around ducts and conduits adjacent to boxes described in above paragraph and on both sides of wall penetration.

.4 Use following paint colour-code:

- Lighting	Yellow
- Power	Blue
- Emergency Power	Orange
- Fire Alarms	Red
- Telephone	Cream
- Control	Brown
- Intercom & Sound	Green

1.32 PAINTING WORK SUPPLIED BY SECTION 09 91 00

- .1 Priming and finish painting of exposed unfinished raceways, fitting, outlet boxes, junction boxes, pull boxes and similar items.
- .2 Electrical subcontractor shall assist in form of supervision, painting works by Section 09 91 00.

1.33 COMMISSIONING

- .1 Be responsible for commissioning of all work provided. The total commissioning requirements:
 - .1 Complete activation of all systems.
 - .2 Re-torquing of all bolted connections in all distribution equipment.
 - .3 Calibration, testing and verification of all systems.
- .2 Commissioning shall commence with activation and verification of all systems in accordance with requirements of the Specifications. This will include but not be limited to the following items to be tested, adjusted and verified:
 - .1 TVSS.
 - .2 Power distribution systems.
 - .3 Emergency lighting system.
 - .4 Generator & ATS.

END OF SECTION

1 GENERAL

1.1 RELATED INSTRUCTIONS

1.1.1 Refer to Section 26 00 00, Electrical General Requirements.

1.2 SCOPE

1.2.1 Provide labelling of electrical power outlets and receptacles throughout the entire building to provide identification of electrical circuit.

2.0 PRODUCT

RECEPTACLE LABELLING

Provide labelling as per photograph below and as follows:

1.1.1.1 Labels for circuits on normal power shall be in black lettering.

1.1.1.2 Labels for circuits on emergency power shall be red lettering.

1.1.1.3 Each label shall contain the distribution panel identification number and circuit number.

1.1.1.4 As-built drawings shall show the distribution panel identification number and circuit number at each receptacle location.

Photograph of typical receptacle labelling:



END OF SECTION

PART 1 GENERAL

1.1 SCOPE / SUMMARY

- .1 Provide all metering equipment required to measure and trend electrical consumption and demand by end use.

1.2 RELATED INSTRUCTIONS

- .1 Refer to Section 26 00 00, Electrical General Requirements.

1.3 DESIGN REQUIREMENTS / PRODUCTS

Provide and install electrical energy sub-meter for measuring:

- .1 Facility incoming electricity

1.4 METERING EQUIPMENT

Electricity Meters

- .2 Internet Protocol (IP) based meter complete with:
 - 1. Built-in web server.
 - 2. Capable of operating with a dedicated IP address (to be provided by the Region).
 - 3. Communications Protocols:
 - A) HTTP/Post capable of pushing data to 3rd party applications/databases.
 - B) Modbus TCP
 - 4. Built-in real-time and historic graphics accessible with any HTML 5 internet browser (computer, tablet, phone) on the Region's network. Data to be displayed in local time, adjusted for daylight savings time.
 - 5. Real-time clock with battery backup and email alert for battery end of life.
 - 6. Time-Stamp:
 - A) Represent date and time
 - B) In UTC time or offset from a specified UTC time
 - C) Resolution: Minimum 1 second
 - 7. Ability to export all stored trend data to comma separated value (.csv) or Microsoft Excel format for importing into spreadsheets. Time-stamps to be exported as a single field with a numeric (non-text) value in local time.
 - 8. Published application programming interface (API) allowing data to be retrieved from the meter via non-proprietary means, such as JavaScript Object Notation (JSON).
 - 9. Built-in trending and data storage:
 - A) years of consumption data (kWh) at 1 minute intervals with time-stamp; and
 - B) 10 years of consumption data (kWh) at 1 hour intervals with time-stamp.
 - C) Stored in non-volatile memory.
 - 10. No special software required to set up meter or access data.
 - 11. Security:
 - A) Unrestricted access to data and graphics over the Region's network.
 - B) Password protection for access to setup, changing settings/parameters and deleting data.

12. Ability to measure, store and trend the following data complete with time-stamp:

- A) Accumulated energy per phase (kiloWatts per hour)
- B) Accumulated total energy (kWh)
- C) Active power per phase (kW)
- D) Active total power (kW)
- E) RMS voltage per phase
- F) RMS current per phase
- G) Power factor per phase
- H) Total power factor.
- I) Line frequency

13. Acceptable product: z3 Controls Inc. NetMeter or equivalent

Current Transformers

- 14. Compatible with electricity meter input without the use of transformers or other devices.
- 15. Linear accuracy +/-1% of reading.
- 16. Accuracy at 10% to 130% of rated current.
- 17. Unburdened current transformers shall not be permitted.
- 18. Acceptable product: Magnelab, Inc. SCT series or equivalent.

Data Cabling

- 19. Cat 5e or Cat 6 Unshielded Twisted Pair (UTP)
- 20. Colour: Green

PART 2 PRODUCTS

2.0 ENERGY METER & SUB METER

- 1. Meter to be supplied and installed by electrical contractor as shown on the drawings.
- 2. Meter to be supplied complete with pulse output.
- 3. Meters must be BACnet listed.
- 4. Manufacturer's technician shall be on site for the startup, to be included with meter supply

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

- 1. Optimize electrical distribution to allow reduction in number of meters by grouping similar/like end use loads.
- 2. Install meter in a painted, hinged NEMA 1 (or better) enclosure complete with modular terminal blocks, finger safe fuse holders, fuses and power supply. Label front of enclosure with meter name, IP address and load(s) measured.
- 3. Provide disconnect at panel board for voltage reference.
- 4. All communication cables to be continuous. No splicing is allowed.
- 5. Affix York Region Property Services Branch Asset Identification tag (to be provided by the Region) to meter prior to installation.
- 6. Sensor and network configuration to be done in consultation with the Region's Property Services Branch.
- 7. Connect meter to the Region's Infrastructure Technology network.
- 8. Commission meter:

- 1. Ensure latest available firmware version is installed in meter.

-
2. Obtain Network information from York Region project manager and program into meter, including IP address, subnet mask, default gateway, primary and secondary DNS addresses.
 3. Set meter clock to current local time.
 4. Set up email alerts as specified and/or requested by the Region's project manager.
 5. Set up trend logging as specified and/or requested by the Region's project manager.
 6. Set default homepage to display real-time demand graphs and consumption statistics.
 7. Verify CT rating is correctly entered in meter setup.
 8. Confirm each voltage and current reading displayed on meter software using voltmeter and clamp-on ammeter.
 9. Verify CT's are wired to corresponding voltage reference and that CT's are installed in correct orientation.
 10. Verify meter information is viewable through a web browser on a device on the Region's network.
 11. Complete and submit Energy Meter Installation/Startup Verification Form
 12. Provide training on meter software use to Region staff including Facilities Operations and Maintenance, and Corporate Energy Services.
 13. Provide meter manufacturer's calibration certificate(s), installation, operations and maintenance manuals and recommended meter recalibration interval(s).

ADDENDUM ME-1

Refer to Section 26 09 13 under Part 2 Products 2.0 and revise as follows

Energy Meter and Sub Meter

1. Meter shall be supplied and installed by electrical Subcontractor as shown on the Drawings.
2. Meter to be supplied complete with pulse output.
3. Meters must be BACnet listed.
4. Manufacturer's technician shall be on site for the startup, to be included with meter supply.

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Conform to General Requirements, Division 1 and Instructions to Bidders.

1.2 REFERENCES

- .1 Comply with Division 1, General Requirements, Instructions to Bidders and all documents referred to therein, and to Section 26 00 00, Electrical General Requirements.

1.3 SCOPE OF WORK

- .1 Supply all labour, tools, service and equipment and provide all the materials required to complete the electrical work specified in Division 26.

1.4 SHOP DRAWINGS

- .1 Shop drawings need not be submitted for standard manufactured items and materials provided they are as specified in the Contract Documents.

1.5 SUBMITTALS

- .1 Submit the following to the Consultant for review:
 - 1. A sample of each proposed type of access door and three (3) prints of reflected ceiling plan drawings showing proposed ceiling access door locations;
 - 2. Location drawings for all required sleeves and formed openings in poured concrete construction.
 - 3. Location drawings for all required openings. These locations must be reviewed and accepted by Consultant prior to the contractor drilling or core drilling.
 - 4. A sample of lamicoid nameplates and list of proposed nameplate legends.
 - 5. Samples of wiring devices and cover plates.

1.6 QUALITY ASSURANCE

- .1 All components shall be C.S.A. and/or U.L.C approved listed and labelled.

2. PRODUCTS

2.1 CONDUIT AND RACEWAYS

- .1 Conduits and Fittings
 - 1. Rigid Galvanized Steel Conduit
 - a. To CAN/CSA C22.2 NO.45-M
 - b. Rigid thickwall galvanized steel threaded conduit
 - 2. EMT
 - a. To CSA C22.2 NO.83-M
 - b. EMT galvanized cold rolled steel tubing
 - 3. Liquid Tight Flexible Steel Conduit Fittings
 - a. To CSA 22.2 No. 56.
 - b. Liquid-tight flexible steel conduit with PVC cover.

- c. Watertight connectors with nylon insulated throat.
- 4. Rigid PVC Conduit
 - a. To CSA C22.2 No. 211.2-M
 - b. Rigid PVC conduit
- 5. Non-Metallic Flexible Conduit
 - a. Non-metallic extra flexible PVC conduit
- 6. Surface Metallic Raceway (SMR)
 - a. Surface metallic raceway to CSA 22.2 No 62
- 7. Rigid Steel Conduit Fittings
 - a. To CAN/CSA C22.2 No. 18
 - b. Galvanized or polymer coated cast steel fittings
 - c. Expansion fittings, watertight with integral bonding jumper suitable for linear expansion and 19 mm³/₄" deflection in all directions
 - d. Sealing condulets for hazardous areas
 - e. Corrosive resistant coated cast steel fittings for corrosive resistant conduit
- 8. Rigid PVC Conduit Fittings
 - a. To CSA C22.2 No. 85-M
 - b. Rigid PVC fittings of same manufacture as rigid PVC conduit
- 9. Liquid Tight Flexible Steel Conduit Fittings
 - a. Watertight connectors with nylon insulated throat
- 10. EMT Fittings
 - a. Compression type, steel
 - i. Gland compression connectors with insulated throats
 - ii. Compression couplings
- 11. Set screw type, steel, concrete-tight
 - a. Connectors with insulated throats
 - b. Couplings
- 12. Minimum size conduit will be 21mm diameter.
- 13. All conduit shall contain a ground conductor.
- 14. All conduit must have adequate support systems complete with fittings as noted in the Contract Documents, outlet boxes, junction boxes, sealing fittings and drains as indicated or as required. Provide hot dipped galvanized steel beam clamps, hot dipped galvanized steel channel type supports where required. Provide six (6) mm threaded galvanized steel rods to support suspended channels and provide all necessary galvanized steel spring loaded bolts, nuts, washers and lock washers. Support systems shall be Thomas & Betts Superstrut or equivalent.
- 15. Provide all conduit, fittings and ducts necessary to complete the distribution of all power, lighting and control conductors to electrical equipment specified under the corresponding Section. Include that necessary for connecting to mechanical heating and ventilating equipment, also equipment specified under other Divisions.
- 16. Fasten conduit with malleable PVC coated galvanized steel two-hole straps at intervals to suit code requirements and job conditions.

2.2 FASTENINGS, SUPPORTS AND SLEEVES

- .1 Galvanized steel, size and load rating to suit application.
- .2 One hole steel straps to secure surface mounted conduits or surface mounted cables 50 mm dia. and smaller. Two hole steel straps for conduits and cables larger than 50 mm.
- .3 Beam clamps to secure conduits to exposed steel work.
- .4 Channel type supports for two or more conduits.
- .5 6 mm minimum dia. threaded rods to support suspended channels.
- .6 6 mm minimum dia. U-bolts.
- .7 Sleeves - schedule 40 steel pipe minimum I.D. 13 mm larger than outside diameter
- .8 . of conduit or cable passing through.
- .9 Acceptable Manufacturers: Burndy, Electrovert, Unistrut or equivalent.

2.3 JUNCTION BOXES

- .1 Code gauge (galvanized) sheet steel EEMAC Type 1 size as required by code for number and size of conduits, conductors and devices, complete with covers, corrosion resistant screws, terminals and mounting channels.
- .2 Screw-on sheet steel covers to match enclosure for surface mounting boxes.
- .3 Covers with 25 mm minimum extension around for flush-mounted junction boxes.

2.4 CONDUIT BOXES - GENERAL

- .1 Size boxes in accordance with latest edition of Electrical Safety Authority (ESA) Ontario Electrical Safety Code.
- .2 Code gauge, galvanized pressed steel for EMT.
- .3 Galvanized cast or pressed steel, for rigid thickwall threaded conduit.
- .4 Corrosive resistant coated: cast boxes for corrosive resistant coated rigid steel conduit with same finish as conduit.
- .5 200 mm square or larger outlet boxes as required for special devices.
- .6 Gang boxes where wiring devices are grouped except in classified hazardous areas.
- .7 Blank cover plates for boxes without wiring devices.
- .8 50 mm x 100 mm outlet boxes for devices, ganged for grouped devices, barriers where required by code.
- .9 Rigid PVC boxes for rigid PVC conduit.

2.5 PULL BOXES

- .1 Code gauge galvanized sheet steel welded construction, EEMAC Type 1.
- .2 Screw-on galvanized sheet steel covers for surface mounting boxes.
- .3 Covers with 25 mm minimum extension around, for flush mounted pull boxes.

2.6 OUTLET BOXES - SHEET STEEL

- .1 Pressed steel single and multi-gang flush device boxes for flush installation, minimum size 100 mm x 50 mm x 38 mm. 100 mm square outlet boxes where more than 1 conduit enters 1 side, with extension rings as required.
- .2 100 mm square or octagonal outlet boxes for lighting fixture outlets.
- .3 119 mm square outlet boxes with extension and plaster rings as necessary for flush mounting devices in gypsum board, plaster or panelled walls.

2.7 MASONRY BOXES

- .1 Pressed steel masonry single and multi-gang boxes for devices flush mounted in exposed masonry walls.

2.8 CONCRETE BOXES

- .1 Pressed steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.9 RIGID CONDUIT BOXES

- .1 Zinc electroplate and polymer enamelled cast FS boxes with factory-threaded hubs and mounting feet for surface mounted switches and receptacles, with gasketted coverplate for exterior work and wet areas.

2.10 OUTLET BOXES - FITTINGS

- .1 Bushings and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of foreign materials.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings for sheet steel metal boxes.

2.11 SURFACE METALLIC RACEWAY

- .1 Surface metallic raceway system for branch circuit and data/control network in finished areas. Surface raceway system shall consist of raceway bases, covers, appropriate fittings and device mounting plates necessary for a complete installation.
- .2 Configuration: Raceways shall be one- or two-piece design with base and snap-on cover. Provide raceways from a company which can provide custom sizes if required. Raceway covers shall be available in tamper-resistant form with screws on access plates and covers of fittings, but not on standard cover lengths.
- .3 Fittings: Fittings shall include flat elbows, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable. Where required, provide tamper-resistant form matching the size of the accompanying raceway base. Provide full capacity corner elbows and tee fittings to maintain a controlled 2 inch cable bend radius,
- .4 Device Brackets and Plates: Provide in sizes to match the raceway width and with mounting holes located to ensure proper mounting of devices.
- .5 Two-piece system of galvanized steel consisting of a base and snap-on cover. Acceptable Product: Wiremold 2000 Series Two-Piece Single-Channel Metal Raceway by Legrand/Wiremold or equivalent. Construction: 0.040 inch (1 mm) metal thickness; 1-9/32 inches (33 mm) wide by 3/4 inch (19 mm) deep; downward facing devices, bend radius control fittings. Finish: Manufacturer's standard Ivory, Gray or custom color as selected.
- .6 Acceptable alternate manufactures include:
 1. Hubbell: Base Trak
 2. Panduit: Pan-Way

2.12 BRANCH CIRCUIT CONDUCTORS

- .1 Conductors
 1. ASTM Class B, soft drawn, electrolytic copper
 2. Stranded
- .2 Insulation
 1. CSA type RW90 XLPE (-40°C)
 - a. Heat and moisture resistant

- b. Low temperature, chemically cross-linked thermosetting polyethylene material
 - c. 600V rated
 - d. For maximum 90°C conductor temperature
 - e. For installation at minimum -40°C temperature
 - f. To CSA C22.2 No. 38
 - 2. CSA type RWU90 XLPE (-40°C):
 - a. Heat and moisture resistant
 - b. Low temperature, chemically cross-linked thermosetting polyethylene material
 - c. 1000V rated
 - d. For maximum 90°C conductor temperature
 - e. For installation at minimum -40°C
 - f. To CSA C22.2 No. 38
 - 3. CSA type T90 NYLON (-10°C):
 - a. Heat resistant
 - b. Flame retardant
 - c. Thermoplastic PVC material with extruded nylon cover
 - d. 600V rated
 - e. For maximum 90°C conductor temperature dry and 75°C in wet locations
 - f. For installation at minimum -10°C
 - g. To CSA C22.2 No. 75-M
- .3 CSA Type AC90 XLPE (-40°C)
 - 1. Conductors
 - a. ASTM Class B, soft drawn, electrolytic copper
 - b. Solid for sizes #10 AWG and smaller
 - c. Stranded for sizes #8 AWG and larger
 - 2. Insulation
 - a. Heat and moisture resistant
 - b. Low temperature, chemically cross-linked thermosetting polyethylene material
 - c. 600V rated for sizes #10 AWG and smaller
 - d. 1000V rated for sizes #8 AWG and larger
 - e. For maximum 90°C conductor temperature
 - f. For installation at minimum -40°C temperature
 - g. To CSA C22.2 No. 38
 - 3. Construction
 - a. 2, 3 or 4 insulated conductors
 - b. Bare ground conductor
 - c. Overall interlocking aluminum armour
 - d. To CSA C22.2 No. 51
- .4 Branch circuit conductors up to and including #12 AWG shall be solid. Branch circuit conductors in sizes larger than #12 AWG shall be stranded. All branch circuit conductors shall be constructed of 90% conductive copper, unless otherwise noted, and shall be approved for 600 volts.
- .5 Electric service, distribution and special conductors are specified in this Section and/or on the drawings.

2.14 FIRE ALARM CONDUCTORS

- .1 Color coded No., 18 AWG twisted pairs, shielded FAS105, FT4, ULC listed meeting specification C22.2 No.208

2.15 WIRE AND CABLE CONNECTORS

- .1 Copper compression type wire and cable terminations for #8 AWG and larger

conductors, colour keyed, sized to suit. Long barrel NEMA 2 hole lugs for sizes #1/0 AWG and larger.

1. Acceptable Manufacturers: Thomas & Betts series 54000, Ideal Powr-Connect, Burndy Hylug or equivalent.
- .2 Twist type splicing connectors, copper, sized to suit, with nylon or plastic shroud for tee connections in #10 AWG and smaller conductors.
 1. Acceptable Manufacturers: Thomas & Betts spring type, Ideal Twister, Marr Marrette or equivalent.
- .3 Conductor compression splice for #10 AWG or smaller.
 1. Acceptable Manufacturers: Thomas & Betts STA-Kon series, Ideal Splices, Burndy or equivalent

2.16 HEAT SHRINKABLE TUBING INSULATION, HEAVY WALL

- .1 Acceptable Manufacturers: Thomas & Betts, Shrink-Kon series, Ideal Thermo-Shrink, TS-46, Raychem tubing WCSM, 3M cable sleeve ITCSN or equivalent.

2.17 WIRING DEVICES - SWITCHES

- .1 Specification grade, general purpose AC switches, manual toggle operated, ivory color, 15A or 20A, 120V, single pole, double pole, three-way, four-way switches as required.
- .2 Acceptable materials:
 1. Single pole: Hubbell - HBL1201 Series or equivalent
 2. Three way: Hubbell - HBL1203 Series or equivalent
 3. Four way: Hubbell - HBL1204 Series or equivalent
 4. Keyed: Hubbell - HBL1221 Series or equivalent complete with 2 keys per switch
 5. (Keys): Hubbell - HBL1209 or equivalent
 6. Motor rated: Hubbell - HBL1221PL c/w pilot light (20A) or equivalent
- .3 Acceptable alternate manufactures include:
 1. Pass & Seymour
 2. Leviton
 3. Arrow Hart
 4. Or equivalent

2.18 WIRING DEVICES - RECEPTACLES

- .1 Standard 15 amp. 125 volt duplex receptacles generally shall be Specification grade Pass & Seymour Cat. No. 26252-WH, CSA #5-15R white finish or equivalent.
- .2 Standard Duplex receptacles indicated to have 'split-feed' shall be two-circuit type wired and connected to a 2 pole common trip circuit breaker in associated panelboard. Orientation of common circuit shall be similar throughout project.
- .3 Special purpose receptacles as noted on the drawings shall be Hubbell Conforming to CSA configurations (Table 46 and Table 47 of Canadian Electrical Code) for non-locking and locking receptacles. Provide attachment cap for each special purpose receptacle.
- .4 Receptacles with integral ground fault interrupter shall be Hubbell No. GF-5262 with matching thermoplastic faceplate.
- .5 Standard T-slot duplex receptacle shall be specification grade 26252-WH. (20A rated – suitable for 15A and 20A rated plug).
- .6 Isolated ground receptacles shall be Pass & Seymour IG26262W or equivalent.
- .7 Receptacles: specification grade suitable for back and side wiring, complete with grounding terminal, colour as required for type of area for straight blade devices and black colour for twist lock devices.

- .8 Receptacles of one manufacturer.
- .9 Acceptable Manufacturers:
 - 1. Pass & Seymour
 - 2. Leviton
 - 3. Arrow Hart
 - 4. Or equivalent

2.19 WIRING DEVICES - COVER PLATES

- .1 Stainless steel Type 302 alloy, vertically brushed, 1mm (1/32") thick cover plates.
- .2 Pressed steel, galvanized.
- .3 Cast covers for cast boxes with gaskets.
- .4 Cover plates of same manufacture as devices.
- .5 Submit samples of each device and cover plate to Consultant for approval. All devices must be approved prior to installation.
- .6 Weatherproof covers shall be while-in-use type polycarbonate body, cover and plates, conform to NEMA3R. Hubbell # WP826MP or equivalent.

2.20 SLEEVES

- .1 In concrete slabs, except as noted below, sleeves shall be #24 gauge galvanized steel or factory fabricated plastic sleeves, each with an integral flange to secure the sleeve to form work construction.
- .2 In waterproof concrete slabs and in other slabs where waterproof sleeves are required sleeves shall be Schedule 40 mild steel galvanized.

2.21 ESCUTCHEON PLATES

- .1 One-piece chrome plated steel sized to completely cover sleeves and complete with set screws to secure the plates to the conduit. Split plates will not be acceptable.

2.22 INSERTS, BEAM CLAMPS FASTENERS, EQUIPMENT HANGERS AND SUPPORTS

- .1 Inserts for concrete formwork shall be Crane Canada type, #4-M Unistrut, or equivalent cast iron inserts, multiple type where required.
- .2 Inserts for precast concrete and existing concrete shall be lead cinch anchors of "WEJ-IT" or self-drilling "STARR" or "PHILLIPS" or equivalent anchors.
- .3 Beam clamps for hanging and support to structural steel shall be Crane Canada Ltd., or equivalent.

2.23 ACCESS DOORS

- .1 Minimum #12 gauge prime coat painted bonderized steel flush access doors, each complete with a heavy frame and anchor, heavy duty rust-resistant concealed hinges, a positive locking screwdriver lock, and mounting and finishing provisions to suit the particular construction in which it is installed. Access door sizes shall suit the concealed work for which they are supplied. Access doors in fire rated ceilings, walls, partitions, structures, etc., shall be U.L.C. listed and labelled and of a rating to maintain the fire separation integrity.
- .2 Where access doors are located in surfaces where special finishes are required, they shall 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.
- .3 Access doors shall be, wherever possible, of a standard size, for all applications. Confirm exact dimensions with the Consultant, prior to ordering.
- .4 Submit a sample of each proposed type of access door to the Consultant for approval.

2.24 WATER RESISTANT PROTECTION

- .1 Where the area is sprinklered and electrical distribution equipment is located in sprinklered areas, enclosures shall be louvred and gasketed and provided with water-tight roof assemblies with overhanging drip shields. The equipment shall be fabricated by the manufacturer in such a way as to prevent sprinkler fluid from entering the equipment and/or interfering with its operation as per the requirements of C.S.A. C22.1 Rule 26-006.
- .2 Weatherproof equipment where noted in the Contract Documents and/or Drawings shall have EEMAC4X enclosures in accordance with the requirements of C.S.A. C22.2 No. 94 Standard.

2.25 PLYWOOD BACKBOARDS

- .1 Plywood backboards, good one side, 4' x 8' x 3/4" fire rated type, unless indicated otherwise. Treat with primer and two coats of fire retardant paint.
- .2 Mount plywood on vertical strapping, on 40 mm centres to provide 10 mm clearance between wall and rear of plywood. Treat strapping similar to plywood.

2.26 FINISH

- .1 Equipment enclosure finish: baked grey enamel, ANSI 49 or ANSI 61.

2.27 PANELBOARDS

- .1 Panelboards as scheduled, shall comprise "Branch" panelboards, with fixed bolted connection thermal-magnetic, quick-make, quick-break, 40°C, calibrated ULC rated 'SWD' switching duty, molded-case circuit breaker branches. "Plug-in" breakers are not acceptable. Multipole breakers shall be common trip type.
- .2 Panelboards shall include the following features:
 1. Flush or surface trim as noted in the Contract Documents.
 2. Concealed hinges.
 3. Combination catch and lock semi flush tumbler type - all keyed alike.
 4. Adjustable self-positioning trims.
 5. Plain trims not displaying any names or Symbols. "Vault" type handles shall not be used except in unfinished areas.
 6. Typed schedules of circuits indicating equipment and area controlled on the backs of panel doors, in a steel trim pocket, covered with transparent non-inflammable plastic.
 7. Insulated neutral block.
 8. Supplementary ground block.
 9. Copper Bus.
 10. Isolated ground bar, as noted.
 11. Surge-suppression system, as noted.
 12. Sprinklerproof design
- .3 Power and Distribution type panelboards shall be breaker type, as scheduled on the Drawings.
- .4 Fusible switch type panelboards shall be complete with suitable fuses as specified under "2.29 Fuses".
- .5 Unless noted otherwise in the Contract Documents, panelboards with main breakers or remote controlled switches shall be provided with an indicating pilot lamp flush mounted in top of face trim which shall be connected to a 15 amp. circuit in the panelboard which shall be locked on and shall serve to indicate when the main breaker is in the closed position. Pilot lamp units shall be LED type or other types approved by the Consultant designed to provide maximum lamp life. Provide

lamacoid nameplate to identify main breaker

- .6 Panelboards of the types scheduled shall comprise the following:

Type 1

Branch panelboards circuit breaker type, 120/208 volt, 3 phase, 4 wire mains, minimum interrupting rating of 14,000 amps. RMS asymmetrical at 120 volts.

Type 2

Power distribution panelboard (CDP), circuit breaker type 120/208 volt, 3 phase, 4 wire mains, minimum interrupting rating of 35,000A, RMS symmetrical at 208 volt. Refer to panel schedules/riser diagram in the Contract Documents for IC rating different than the minimum.

- .7 Interrupting capacity indicated for panels is minimum rating. The rating shall be increased as required to suit Coordination Study at no extra cost. A Series Rated System is acceptable if it meets all CSA and approvals for short circuit current protection.

- .8 Acceptable Manufacturers are:

1. Cutler-Hammer
2. Square 'D'
3. Siemens
4. GE
5. Or equivalent

2.28 SWITCHES

- .1 Provide fusible and non-fusible switches, NEMA Type 'HD' with quick-make, quick-break contacts, horsepower-rated where required, to match the motor protected. Provide holders to accept specified fuses. Switches to include mechanical cover interlocks and line side Barriers.
- .2 Where applicable and available, switches shall be CSA "Approved For High Service Factor".
- .3 Provide safety disconnect switches adjacent to motors and other equipment when required by regulations.
- .4 Acceptable Manufacturers are:
Square 'D'
Cutler-Hammer
Siemens
Or equivalent

2.29 FUSES

- .1 Provide fuse holders in fusible equipment with a complete set of proper size Form 1, HRC Nema J or L current limiting fuses. Fusible equipment so provided shall be adapted to reject CSA Standard C22.2 No. 59 fuses. Fuses shall be of one manufacturer throughout.
- .2 Provide one complete set of spare fuses for each rating and type used, unless otherwise scheduled.
- .3 Fuses for motor circuits shall be Class J time delay, selected for motor protection as recommended by manufacturer.
- .4 Apply Thomas & Betts "Kopr/Shield" or equivalent conductive anti-seize compound to all fuse ferrules and holders.
- .5 Acceptable Manufacturers are:
Bussman Limitron

English Electric
Federal Pioneer Electric - "Econolim" Gould – Shawmut
Or equivalent

3. EXECUTION

3.1 GENERAL CONDUIT AND CONDUCTOR INSTALLATION REQUIREMENTS

- .1 Install conduit and conductors concealed in all finished areas, and concealed to the degree made possible by finishes in partially finished and unfinished areas. Conduit may be exposed in unfinished area such as Electrical Rooms and Mechanical Rooms, unless otherwise noted on the Drawings or specified in the Contract Documents. Refer to and examine the architectural Drawings and room finish schedules in the Drawings to determine finished, partially finished and unfinished areas of the building.
- .2 Arrange exposed conduit and/or conductors to avoid interference with other work and parallel to the building lines, where horizontal conduits and/or conductors are exposed, install as high as possible. Do not install conduit and/or conductors within 150mm of flue or heating pipes or equipment.

3.2 CONDUIT AND EMT - GENERAL

- .1 Run parallel or perpendicular to building lines.
- .2 Group raceways wherever possible. Support on channels.
- .3 Install expansion joints as required.
- .4 Run raceways in web portion of structural steel columns and beams.
- .5 Do not drill structural members to pass through conduit.
- .6 Locate raceways not less than 125 mm clear where parallel to steam or hot water lines with a minimum of 75 mm at crossovers.
- .7 Use metallic raceway where temperatures exceed 75°C or where enclosed in thermal insulation.
- .8 All conduits to contain insulated green ground wire.
- .9 Install 6 mm diameter nylon pull cord in empty raceways.
- .10 EMT and non-metallic conduits to contain insulated green ground wire.

3.3 CONDUIT AND FITTINGS

- .1 Minimum conduit sizes:
 1. Surface installation 21mm trade size conduit
 2. Embedded in concrete 27mm trade size conduit
 3. Directly buried 53mm trade size conduit
- .2 Conduit application and type:

Application	Type
.1 Corrosive Areas	Rigid Steel
.2 Hazardous Areas	Rigid Steel
.3 Outdoor Areas	Rigid Steel
.4 Embedded in Concrete, Other than Grade Slab	Rigid PVC
.5 In or Below Grade Slab	Rigid PVC
- .3 Exposed in unfinished areas up to 3m above finished floor, use rigid galvanized steel, above 3m use EMT.
- .4 Connection to motors and equipment subject to vibration use liquid tight flexible steel conduit.
- .5 Use field threads on rigid conduit of sufficient length to draw conduits up tight.
- .6 Do not bend coated steel conduit. Use elbows for deflections.

- .7 Do not install conduit in or under slab.
- .8 Use factory "ells" where 90° bends are required for 27mm trade size and larger conduits.
- .9 Bend conduit offsets cold. Do not install crushed or deformed conduits and avoid trapped runs in damp or wet locations. Prevent the entrance of water and lodging of concrete, plaster, dirt, or trash in conduit, boxes, fittings, and equipment during course of construction.
- .10 Where conduit joints occur in damp or wet locations, make joints watertight by applying an approved compound on the entire thread area before assembling. Draw up all conduit joints as tightly as possible.
- .11 Cap exposed empty conduits which do not terminate in outlets, panels, cabinets, and similar items, with standard galvanized plumber's pipe caps.
- .12 Plug empty conduits which terminate flush with floors or walls with flush coupling and brass plug.
- .13 Install conduit sleeves for all exposed conduits and cables passing through walls, ceilings, or floors, and fill void between sleeve and conduit with caulking. If fire-rated caulking is required by code, use same class as walls, ceilings or floors.
- .14 Terminate conduit stubbed up through concrete floor for connection to free standing equipment with a coupling flush with finish floor, and extend rigid conduit to equipment, except where required, use flexible conduit from a point 150 mm above floor.
- .15 Install double locknuts and bushings on all rigid conduit terminations into threadless openings. Increase length of conduit threads at terminations sufficiently to permit bushing to be fully seated against end of conduit.
- .16 Mechanically bend steel conduit.
- .17 Install sealing condulets in conduits at hazardous area boundaries.

3.4 CONDUITS IN POURED CONCRETE

- .1 Locate conduits to suit reinforcing steel. Secure firmly to prevent movement during pour.
- .2 Clear each conduit with mandrel and brush before concrete sets.
- .3 Protect conduits from damage where they stub out of concrete.
- .4 Install sleeves where conduits pass through slab or wall.
- .5 Provide oversized sleeve before membrane is installed where conduits pass through waterproof membrane. Use cold mastic between sleeve and conduit.
- .6 Encase conduits completely in concrete; provide 50 mm (2") minimum concrete cover.
- .7 Replace with exposed conduit, any conduit run found to be obstructed after concrete sets.
- .8 Core-line conduit is not allowed and shall not be used.

3.5 EMT AND FITTINGS

- .1 Minimum EMT size: ¾ (21) trade size conduit.
- .2 EMT Application
 - 1. Exposed in unfinished areas, above truss level and for drops in column web to 3m above finished floor. Use rigid steel conduit below 3m.
 - 2. In block walls and stud partitions.

3.6 JUNCTION BOXES

- .1 Install junction boxes in inconspicuous but accessible locations. Secure to structure.
- .2 Install terminal blocks on mounting rails, for termination of each wire and cable regardless of size.
- .3 Only one voltage source is permitted in a junction box.
- .4 Install barriers to separate different auxiliary systems

3.7 PULL BOXES

- .1 Install pull boxes in inconspicuous but accessible locations. Secure to structure.
- .2 Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

- .3 Only one voltage source is permitted in a pull box.
- .4 Install barriers to separate different auxiliary systems.

3.8 OUTLET AND CONDUIT BOXES

- .1 Install conduit outlet boxes for conduit up to 32 mm and pull boxes for larger conduits.
- .2 Support boxes independently of connecting conduits.
- .3 Seal boxes during construction to prevent entry of debris, dust and dirt.
- .4 For flush installations mount plaster rings to box, flush with wall surface to permit wall finish to come within 6 mm of opening.
- .5 Provide correct size of openings in boxes for conduit, armoured cable connections. Reducing washers will not be acceptable.
- .6 Install switches and other controls close to door lock or latch jambs and other openings, maintaining a minimum of 100 mm from trims of doors (except where installed in door frames of metal partitions) check door swings.
- .7 Install 100 mm square or octagonal outlet boxes for lighting fixture outlets.

3.9 MASONRY BOXES

- .1 In block walls use deep boxes to provide clear space around knockout for AC90 cable entry.

3.10 SURFACE METALLIC RACEWAY

- .1 Install surface metallic raceway in finished areas where conductors – both power and data/control cannot be run in the existing raceway. Raceway is to be supplied and installed complete with all necessary fittings, hardware and device brackets for configuration as noted on the drawings for a complete functional system.
- .2 Install conduit system, wiring and devices as indicated.
- .3 Ensure raceway is installed as per manufactures recommendations.
- .4 Where the raceway ends at a wall install end cap.

3.11 INSTALLATION OF BRANCH CIRCUIT CONDUCTORS

- .1 Install wiring in raceways unless noted otherwise in the Contract Documents.
- .2 Minimum wire sizes:
 - 1. Power and lighting -No. 12 AWG
 - 2. Control -No 16 AWG
- .3 Wire and cable application and type:
 - 1. Lighting branch circuit in classrooms use T90 nylon in existing raceway of surface metallic raceway.
 - 2. Lighting branch circuits in gymnasium use T90 in raceway surface mounted
 - 3. Lighting branch circuits in corridors use T90 in raceway surface mounted to ceiling boxes
 - 4. Receptacle branch circuits use T90 nylon.
 - 5. Ceiling boxes to luminaires in suspended ceiling use T90 nylon or AC90 cable.
 - 6. Branch circuits other than those covered above use RW90
 - 7. Equipment feeders and circuits use RW90
 - 8. Type AC90 cable length limitations:
 - a. Ceiling box to luminaire:
 - 1.2m maximum in non-accessible ceilings
 - 1.8m in accessible ceilings
 - b. Junction box to outlet: 3m maximum.
 - 9. Use lubricant when pulling wires into conduit. Ensure that wires are kept straight and are not twisted or abraded.
 - 10. Neatly secure exposed wire in apparatus enclosures with approved supports or ties.

11. Junctions of all conductors shall be done with Ideal Wing nut #450 Series for conductors from #14 AWG to #8 AWG.
12. For all conductors larger than #8 AWG junctions shall be done with Burndy Servit or approved equivalent connectors wrapped with 3 M #33 Scotch tape.
13. Maximum voltage drop for 24V DC wiring to remote lighting heads shall be 5% max at the farthest remote head. Size conductors accordingly.

3.12 CONNECTORS

- .1 Install compression terminations and splices in accordance with manufacturer's written instructions.
- .2 Make splices in junction boxes.
- .3 Make connections in lighting circuits with twist type splicing connectors.
- .4 Terminate and splice conductors No. 8 and larger at terminal blocks in junction boxes.
- .5 Seal terminations and splices exposed to moisture, corrosive conditions or mechanical abrasions with heavy wall heat shrinkable insulation.
- .6 Install fixture type connectors and tighten. Replace insulating cap.

3.13 INSTALLATION OF FIRE ALARM CONDUCTORS

- .1 Provide all required Fire Alarm conductors, generally as specified unless otherwise noted in the Contract Documents.
- .2 Install all Fire Alarm wiring in conduit, unless specifically otherwise noted in the Contract Documents.
- .3 Any special requirements pertaining to Fire Alarm wiring will be specified on the Drawings.

3.14 WIRING DEVICES – RECEPTACLES

- .1 Install receptacles vertically, use gang type outlet box where more than one receptacle is required in a location.
- .2 Where split receptacle has a portion switched, mount vertically and switch upper portion.
- .3 Coordinate with the requirements of architectural and interior design Drawings for final positioning and mounting heights of power and voice/data receptacles. Where there is disagreement between electrical and architectural Drawings, take the architectural Drawings as correct.
- .4 Maintain clearances between receptacle outlet boxes and millwork as stipulated on the Drawings.
- .5 Align and evenly space outlet boxes that are mounted as a group.

3.15 WIRING DEVICES - SWITCHES

- .1 Install single throw switches with handle in UP position when switch is closed.
- .2 Install switches in gang type outlet box when more than one switch is required in a location.
- .3 Mount toggle switches at height indicated in the Contract Documents.

3.16 WIRING DEVICES - COVER PLATES

- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates designed for flush outlet boxes on surface-mounted boxes.
- .4 Provide plaster ring where necessary.

3.18 INSTALLATION OF SLEEVES

- .1 Where conduits, raceways and conductors pass through structural poured concrete, install

- sleeves, to suit structural details.
- .2 Size sleeves, unless otherwise noted in the Contract Documents, to leave 12mm clearance around the conduit, raceway, etc. Pack and seal the void between the sleeves and the conduit, raceway, conductor etc. for the length of the sleeves as follows:
 1. Pack sleeves set in interior concrete slabs, masonry walls, fire rated partitions, etc., with a U.L.C. and C.S.A. approved fire barrier caulk equal to 3M #CP25.
 2. Pack sleeves set in exterior walls with lead wool or oakum and seal the ends of the sleeves water-tight with an approved non-hardening sealant compound. Co-ordinate with the waterproofing trade.
 3. Submit the concrete reinforcement detailed, at the proper times, drawings, indicating all required sleeves, recesses and formed openings in poured concrete work. Such drawings shall be completely and accurately dimensioned and shall relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
 4. Install sleeves of a water protecting type in the following locations:
 - a. In Mechanical Room floor slabs except where on grades.
 - b. In slabs over Mechanical, Fan, Electrical and Telephone equipment rooms or closets.
 - c. In all floors equipped with waterproof membranes.
 - d. In the roof.
 5. "Gang" type sleeving will be permitted only with the Consultant's approval. All sleeves locations in slabs shall be approved by structural Engineer.
 6. Terminate sleeves for work which will be exposed so that the sleeve is flush at both ends with the wall, partition or slab surface so that the sleeves may be completely covered by escutcheon plates.
 7. Openings for multiple conduit or conductor runs, etc., will be provided by the Contractor in accordance with the Division of Work which specifies the particular construction in which the opening is required. Carefully co- ordinate the opening locations with the requirements of the particular Division and ensure that openings are suitably sized and located. Seal the space between the opening and the conduit, conductors, etc., for the length of the opening as for sleeves above.
 8. Where a round or formed opening is required, where placement of a sleeve has been missed, or where provision of an opening has not been properly coordinated with the requirement of Division 03 - Concrete, neatly cut a suitably sized hole or opening using proper tools to the approval of the Consultant. Prior to cutting any such hole or openings, determine whether or not any reinforcing steel or services, are concealed behind the surface where the holes or openings are to be cut and be responsible for all costs incurred for correcting any damage caused to the structure or services due to cutting holes or openings without prior study and approval by the Consultant.

3.19 INSTALLATION OF ESCUTCHEON PLATES

- .1 Provide escutcheon plates over all exposed conduit passing through walls, floors, ceilings, partitions, furrings etc., in finished areas.

3.20 INSTALLATION OF INSERTS, BEAM CLAMPS, FASTENERS, HANGERS AND SUPPORTS

- .1 Install all inserts, beam clamps, fasteners, and similar hardware required for conduit, duct, raceway, conductor, etc., and equipment hanger and/or support materials in a manner that best suits structural details.
- .2 Accurately and properly set concrete inserts in the concrete framework.
- .3 For runs of three (3) or more conduits, raceways, or conductors in concrete formwork, use multiple type inserts used for the smallest conduit in the group.
- .4 Where inserts are required in precast concrete and in concrete work where concrete inserts have not been installed, drill a neat hole of the proper diameter

- and depth in the concrete and insert an anchor to accept the hanger rod, bolt, etc., or where concrete mass permits, use self-drilling concrete anchors.
- .5 Fasten hangers and support provisions to brick or masonry with expansion shields and machine bolts, or for light loads, use plugs, and screws.
 - .6 In cavity walls and/or ceilings use two (2) wing toggles and for heavy loads, provide steel anchor plates with two (2) or more toggles to spread the load.
 - .7 Provide beam clamps for attaching, hanging and/or support provisions to the Consultant, weld the hanging and support provisions to the structural steel.
 - .8 Explosive power actuated fasteners will not be permitted unless specific approval for their use has been obtained from the Consultant.
 - .9 Securely mount plywood backboards to structure or use independent mounting channels, secured to floor.

3.21 INSTALLATION OF ACCESS DOORS

- .1 Install access doors to give access to all junction boxes, pullboxes, conductor joints and other similar 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 Before commencing installation of electrical work, prepare, on a set of reflected ceiling plans, complete layouts of all ceiling access door locations that will be required. Submit these layouts to the Consultant for approval and show the exact sizes and locations of such ceiling access doors. Locate access doors in walls and partitions to the Consultant's approval, and arrange electrical work to suit.
- .3 Access doors shall be supplied and installed by the Contractor according to the requirements of the Division of Work which specifies the particular type of construction in which the access doors are required. .
- .4 Access doors shall be, wherever possible, of a standard size, for all applications. Confirm exact dimensions with the Consultant, prior to ordering.
- .5 Submit a sample of each proposed type of access door to the Consultant for approval.

3.22 PAINTING AND FINISHES

- .1 Provide all painting and patching to match existing services as required.
- .2 All exposed electrical fittings, supports, hangers, frames conduit, racks, boxes, raceways and similar material and apparatus shall be galvanized or finished with corrosion resistant primer ready to accept paint. Take special care when priming work exposed to the elements or in wet areas to prevent rust or corrosion from damaging adjacent surfaces.
- .3 Touch up and/or repaint any factory finished equipment that has been scratched or otherwise damaged during installations.
- .4 Provide for all patching and painting for all removals and as required. Painting shall be completed to the approval of the Consultant and Owner. Paint shall match adjacent surfaces. Include all costs in the Contract Price.
- .5 Where cutting, patching, fire stopping and construction involves painted surfaces these must be painted to match the surrounding surfaces or as directed by Consultant.

3.23 STANDARD IDENTIFICATION

- .1 Identify electrical work as specified below.
- .2 For each piece of electrical equipment from the existing panel board up to and including battery packs and for any other piece of equipment where specified in this Section, provide engraved lamacoid identification nameplates. Nameplates shall generally be lamacoid black with white letters and with bevelled edges, secured to apparatus with stainless steel screws. Warning signs, if and when required, shall be red with white lettering.
- .3 Exact nameplate wording and sizes must be approved by and confirmed by the Consultant prior to manufacture.

- .4 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting the outside of the covers. Paint colours shall be in accordance with the following schedule in 3.23.5 below:
- .5 Colour code conductors throughout to identify phases, neutrals and grounds by means of self-laminating coloured tape, coloured conductor insulation, or properly secured coloured plastic discs. Colours shall be as follows:

.1	Phase A	-	Red
.2	Phase B	-	Black
.3	Phase C	-	Blue
.4	Ground	-	Green
.5	Neutral	-	White

3.24 CUTTING AND PATCHING

- .1 Inform other trades in time concerning required openings. In work already finished, cutting and patching shall be done by the trades installing the affected work at no cost to the owner. Obtain the approval of the Consultant, before doing any cutting.

3.25 PROVISIONS FOR SERVICES CROSSING BUILDING EXPANSION JOINT

- .1 Wherever services (conduit, cables, etc.) cross building expansion joints, install the services in such a manner to permit free movement without imposing additional stress or loading upon the support system, and to prevent excessive movement at joints and connections.

3.27 FIELD FABRICATED METAL WORK

- .1 Clean and prime paint field fabricated metal work.
- .2 After fabrication deburr, scrape, grind smooth, wire brush with power brush and degrease metal work.
- .3 Prime paint steel with 1 coat of CISC/CPMA 2.75 oil alkyd primer.
- .4 Prime paint aluminum as follows: wash with detergent solution and wipe down with SSPC-SP1 solvent. Apply Glidden #Y-5229 or equivalent primer to 1.5 mils DFT.
- .5 For brass and bronze alloy materials, prepare as for aluminum but apply 1 coat of CAN/CGSB-1.40-M zinc chromate primer.

3.28 TESTS

- .1 Branch circuit balancing.
- .2 Connect all new branch power circuits to existing panel boards so as to balance the actual loads (Wattage) within 5%.

3.29 MOUNTING HEIGHTS

- .1 Mounting heights of outlets, top of outlet to finished floor, except for exposed masonry construction, shall generally be as follows:
- .2 Lighting Switches - 1200 mm
- .3 Receptacles - 400 mm above finished floor or 250 mm above counter top.
- .4 Television Outlets - 400 mm
- .5 Telephone/data Outlets - 400 mm
- .6 Panelboards - 2000 mm to top of trim for standard panels.
- .7 Install all fire alarm equipment/devices in accordance with CAN/ULC-S524 "Standard for the Installation of Fire Alarm Systems" latest edition, the manufacturer's instructions, Ontario Building Code, Underwriter's Laboratory of Canada, Electrical Safety Code, the

- Contract Documents and requirements of Local Authority Having Jurisdiction.
- .8 Refer to Architectural Drawings for exact location. Report to Consultant any discrepancies in the Contract Documents.

3.30 EXCAVATION & BACKFILL

- .1 Provide necessary excavating and backfilling inside and outside of the building required for work of this Division, except as modified below.
- .2 Keep excavations free from water, pump as necessary. Provide and maintain adequate heat, shoring, other necessary temporary protection.
- .3 Trench excavation shall be carried out in strict conformity with the Ontario *Occupational Health and Safety Act* O. Reg 213/91 Construction Projects.
- .4 Excavation for underground services shall be to required depths and dimension and shall be prepared as required, so that no portion of any conduit or duct bank, bears directly against any rock or other hard surface.
- .5 Remove and dispose of all surplus excavated material.
- .6 Backfill promptly after approval of work. Prevent damage to or displacement of walls, piping, conduits, waterproofing and other work.
- .7 For direct buried conduit and cable in all soiled conditions excavate to 150 mm (6") below and a minimum of 200 mm (8") to either side of the cable run. Fill back with a bedding of sand.
- .8 Where excavation is necessary in proximity to and below the level of any footings, provide a sleeve at the proximity line and back fill with 20 mPa concrete to the level of the highest adjacent established by the Architect.
- .9 Provide sleeves under all roads and paved areas.
- .10 Before backfilling, obtain approval. Remove all shoring during backfilling.
- .11 Backfill trenches within 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 one foot. Hand or machine compact the balance up to grade, using approved equipment.
- .12 Backfill trenches outside buildings, not under roads, parking lots, or traffic areas, up to a compacted level of 450 mm (18") above the duct bank with individual layers of material up to 150 mm (6") thick, hand compacted to a density of 95% Standard Proctor, using sand or granular 'A' gravel. Backfill the balance to 95% Standard Proctor, using industry-approved equipment.
- .13 Backfill all other trenches outside buildings with granular 'A' gravel in layers not exceeding 150 mm (6") thickness, compacted to 100% Standard Proctor density up to grade level; manual compaction up to 450 mm (18") and mechanical compaction, using approved equipment, for the balance.
- .14 Make good work where damaged by excavation and filling work of this Division. Repair any subsequent settlement of fill placed under this Division and pay all costs in replacement of other work damaged by such settlement and restoration.

3.31 SUPPORT FOR UNDERGROUND SERVICES

- .1 Provide suitable solid support to comply with requirements of authorities having jurisdiction, where solid, undisturbed earth stratum is not available for support of underground services. Minimum requirements where services pass through backfill or exterior foundation walls shall be 20 mPa concrete fill, full depth to undisturbed earth.
- .2 Reinforced concrete duct banks shall be keyed into sides of foundation walls. Extend and connect reinforcing steel of duct banks to reinforcing steel of foundation wall construction to prevent failure at the junction of the pipe support and wall.

3.32 CONCRETE WORK

- .1 Provide concrete work where required for work of the in accordance with applicable requirements specified in Division 03 - Concrete.

- .2 Electrical subcontractor shall provide all necessary forming and reinforcing required and as noted or detailed for outdoor luminaires, and Duct Bank.
- .3 Provide concrete bases where required for the work of this Division. Comply with applicable requirements specified in Division 03 - Concrete. Use 20 MPa concrete. Make exposed surface smooth finish, with suitable chamfer or radius on exposed external corners and edges. Concrete bases in direct contact with floor slab shall be dowelled into concrete floor slab with not less than four 13 mm (1/2") diameter steel rods which shall be connected to floor slab reinforcing steel.
- .4 Provide 100 mm (4") high housekeeping pads for all floor mounted electrical equipment, such as switchboard, generator, distribution panels and transformers, etc.

3.33 NAMEPLATES & SCHEDULES

- .1 Identify electrical equipment supplied under this Division with 3 mm thick black laminated plastic nameplate to indicate equipment controlled to provide instruction or warning. Fasten each plate with two chrome plated screws. Lettering shall be 6 mm high for small devices such as control stations and at least 13 mm high for all other equipment. Submit a list of proposed nameplates for approval before manufacture.
- .2 Provide panelboards with typewritten schedules identifying outlets and equipment controlled by each branch circuit including existing panels being changed. Protect schedules with non-flammable clear plastic.
- .3 Identify junction boxes, pull boxes, cover plates, conduits and the like, provided for future extension, indicating their function (e.g. power, fire alarm, communication).
- .4 Verify room names and numbers prior to listing on nameplates and schedules.

3.34 PANELBOARDS

- .1 Provide handle locking devices on circuit breakers feeding Plumbing, Heating, Ventilating equipment and controls and all auxiliary systems, time switches, and other devices as noted in the Contract Documents. Paint handles white, to permanently identify location and function. Provide 30 spare handle locking devices for future use.
- .2 Circuit numbers on Drawings do not necessarily correspond to the numbers on the lighting panels. Circuits sharing a common neutral shall not be connected to the same main. Panel circuit breakers which are used directly for the switching of lighting fixtures shall be grouped in consecutive numbers commencing at breaker number one.
- .3 Use "Panduit" lok-strap cable ties for panelboard branch wiring.3.34.4. Provide empty conduits from flush panelboards, and others as noted in the Contract Documents, terminating in accessible ceiling spaces, sized to accommodate spare and space breaker provisions. One 25 mm (1") conduit for each three spare breakers or spaces.

3.35 ELECTRIC WORK FOR OTHER DIVISIONS

- .1 Examine Architectural and Mechanical (Plumbing, Heating, Ventilating and Air Conditioning) Drawings and specifications to determine extent of electrical work in connection with these Divisions which is to be done under the work of the Electrical Division.
- .2 In general, all motor starters and associated controls for mechanical equipment will be supplied under that Division of the work which supplies the equipment, for installation and connection to both source and load under the work of the Electrical Division 16. Refer to the Mechanical Divisions 21, 22 and 23 Specifications, drawings, and schedules for the exact intent and extent of the work to be included in the Electrical Divisions 25, 26, 27, 28 and 29.
- .3 Co-ordinate the exact location and verify characteristics of electrical provisions for the work of the Mechanical Divisions 21, 22 and 23.
- .4 Coordinate locations of starters, motors and associated equipment with the work of the Divisions 21, 22 and 23 Mechanical Trade Sections to ensure proper location of equipment. The exact locations of conduit terminations at Mechanical units shall be determined from

- equipment manufactures' approved shop drawings. Conduits must be installed to enter only in the locations designated by equipment manufactures.
- .5 Provide safety switches required for disconnection of remotely controlled motors, and where required at motors by CEC regulations whether shown on the drawings or not. Where required at fan motors, they shall be concealed in the fan housing if possible.
 - .6 Provide for the 120 volt mechanical equipment where noted in the Contract Documents, all necessary wiring and connections including wiring and installation of starters, thermostats, aquastats, speed controllers and time switches controlling equipment.
 - .7 Where motor starters, switches and the like, are grouped together, a suitable 19 mm (3/4") thick plywood panelboard shall be provided to which all such equipment shall be secured. Provide all necessary angle iron supports for support of panelboard and paint entire assembly with two coats of fire retardant type enamel acceptable to Building Inspection Department.
 - .8 Provide weatherproof unfused safety disconnect switches, fastened to exterior of roof mounted units, to approval.
 - .9 Connect high temperature thermostats "Firestats" provided in ductwork by Mechanical subcontractor, to exhaust fan systems, to provide fan shutdown on activation.
 - .10 Refer to Equipment Schedule, in the Contract Documents, for further Details.
 - .11 Architectural Sections:
 - .12 In addition to the work shown, perform the following:
 1. Provide all wiring and connections for Owner's Equipment, noted in the Contract Documents.
 2. Provide power and empty conduit for door hardware, electric hold open devices, magnetic-locks, and similar items. as indicated in the hardware list in the door hardware schedule.

3.36 GROUNDING

- .1 Ground all electrical systems in accordance with provisions of the Ontario Electrical Safety Code.
- .2 Provide a grounding electrode in accordance with Section 10 of the Canadian Electrical Code.
- .3 Install grounding conductors to permit the shortest and most direct path from equipment to ground. Install grounding conductors in rigid galvanized conduit with both conductor and conduit bonded at both ends. Provide bonding jumpers with industry-approved clamps to maintain ground continuity of metallic raceway systems at all expansion joints.
- .4 Ground connections to grounding conductors shall be accessible for inspection and made with industry-approved solderless connectors bolted to the equipment of structure to be grounded. Clean contact surface prior to making connections to ensure proper metal to metal contact. Connections shall be of the type that grounds both conduit and conductor, and cap screws, bolts, nuts and washers shall be silicon bronze.
- .5 Provide copper ground bus 0.25" deep x 2" wide complete with insulated supports, fastenings and connectors. Install copper grounding bus mounted on insulated supports on wall of main electrical room. Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 2/0AWG.
- .6 Provide all non-corroding accessories necessary for the grounding system of type, size, material as indicated, including but not necessarily limited to:
 1. Grounding and bonding bushings.
 2. Protective type clamps.
 3. Bolted type conductor connectors.
 4. Thermit welded type conductor connectors.
 5. Bonding jumpers, straps.
 6. Pressure wire connectors.
- .7 Testing
 1. Perform ground continuity and resistance tests using method appropriate to Site conditions and to approval of Consultant and ESA.
 2. Perform tests before energizing electrical system.

3. Disconnect ground fault indicator during tests

END OF SECTION

1. GENERAL

1.1 RELATED INSTRUCTIONS

- .1 Refer to Section 26 00 00, Electrical General Requirements.

1.2 SCOPE

- .1 Work includes, but is not limited to:
 - 1. Secondary ductbank and secondary cables including termination from pole mounted transformer to service entrance switchboard. Terminal connectors shall be provided as per the Local Hydro Authority's requirements/standards.
 - 2. Grounding System.
 - 3. Supply and install a 1.25" rigid PVC conduit complete with fish wire from Service Entrance Board metering compartment to outdoor P-base Hydro meter cabinet (supplied by the Local Hydro Authority and installed by the electrical Subcontractor. Provide phone line to meter and coordinate on site with the Local Hydro Authority for the location of the meter enclosure prior to rough in.
 - 4. Obtaining approvals from, co-operation and scheduling the work with Supply and Inspection Authorities, before commencing work.
 - 5. Preparation of all necessary working drawings for submission to Inspection Authorities.

1.3 SYSTEM CO-ORDINATION & SHORT CIRCUIT STUDY

- .1 Characteristics of protective devices (relays, circuit breakers, fuses and the like) shall be selected to provide a coordinated fully-rated protective system; affording minimum fault-clearing times, and fault values.
- .2 Retain services of approved testing company to perform protective co-ordination study to establish optimum settings and selections for all protective devices.
- .3 Study shall be plotted on reproducible logarithmic paper (K&E #48-5257) illustrating:
 - 1. Study single line diagram, showing steady-state and transient values.
 - 2. Three phase bolted fault current, symmetrical and asymmetrical, and minimal arcing ground fault values.
 - 3. Time-current characteristics curves of all pertinent relays, breakers, fuses, etc. including Supply Authority's primary protective devices, for the complete project.
 - 4. Thermal damage curves for cable, transformers, motors and the like.
 - 5. Summation chart showing all ratings and settings referenced to the appropriate time-current characteristic curve.
- .4 Provide full scale transparencies for time-current characteristic curves of proposed devices.
- .5 Submit study for approval by the Consultant. Make all necessary subsequent changes to form "as-built" document.
- .6 Provide system coordination and short circuit study for complete high voltage and 120/208V power system

1.4 ARC FLASH PROTECTION

- .1 Retain the services of an industry-approved testing company to perform arc flash hazard study and calculation for all switchboards, panel boards, transformer, panels, control panels, MCC, meters, disconnect switches, breakers, etc, that require examination, adjustment, servicing, or maintenance while energized.

- .2 The study and calculation shall meet IEEE 1584-2002, Guide for Performing Arc-Flash Hazard Calculations.
- .3 Provide arc flash report to include the following, but not limited to:
 1. Results of the study and calculation.
 2. Detailed hazard/risk category (0 to 5).
 3. Voltage shock hazard, incident current and energy.
 4. Flash protection boundary and shock approach boundaries.
 5. The protection plan including safe work procedures, preventive maintenance programs, personal protective equipment, etc. The protection plan shall meet CSA Z462-08, workplace electrical safety.
- .4 Based on the arc flash report, provide required labels state the existence of arc flash hazard and the corrective action to take. The labels must meet ANSI Z535.4-2002, product Safety signs and Labels.

1.5 INSPECTION & TESTING

- .1 Systems, equipment and all major items of material shall be tested to the satisfaction of the Consultant, and as required to establish compliance with plans and specifications, and with the requirements for the Supply and Inspection Authorities.
- .2 Faulty and defective equipment shall be replaced with new materials Conductors which are found to be shorted or grounded, or to have less than proper insulation resistance, shall be replaced with new conductors.
- .3 Tests shall include but are not limited to the following:
 1. Test of power cables shall include megger tests to establish proper insulation resistance, and phase-to-ground resistance of cables.
 2. of all adjustable electrical protective devices of switchgear to establish calibration and operation in accordance with specifications and approved co-ordination curves.
 3. Visual examination of switchgear to determine adherence to allowable manufacturing tolerance and compliance with manufacturer's recommended installation requirements.
 4. Proper functioning of all systems.
 5. Polarity tests - to establish proper polarity connections to all sockets and receptacles.
 6. Calibration setting, and test-tripping, of all protective relays and devices, using "Primary-injection" equipment, in accordance with approved co-ordination schedule.
 7. Test of all alarm devices and contacts.
 8. Test of system neutral to establish proper insulations resistance and isolation of neutral from ground except for required ground connection at service
 9. Inspection after system is energized shall include infrared thermographic examination of current carrying parts in switchgear, transformers, and at ducts. The Contractor shall cooperate with inspection personnel, open all equipment enclosures to permit inspection, and make good defective conditions.
- .4 Testing Company
 1. Retain the services of an independent testing company, to the Consultant's approval to perform the above tests.
 2. The testing company shall submit test results directly to the Consultant.
 3. Include copy of tests in Maintenance and Operating Manual.

.5 Certification of Tests

1. When work is complete, submit three copies of test results and a signed statement listing all tests that have been performed as required by specifications and manufacturer's instructions.

2. **PRODUCTS**

2.1 **SERVICE ENTRANCE SWITCHBOARD**

- .1 Provide metal enclosed 120/208 volt switchboard as arranged on the Drawings and further described herein, and detailed on the Drawings.
- .2 The switchboard shall comprise an indoor, metal enclosed free standing assembly employing breakers manufactured by Federal Pioneer or equal.
- .3 Assembly shall be factory assembled CEMA Type 2 "Sprinkler Proof" construction, and constructed in accordance with applicable CEMA and AIEE Standards. The equipment design shall be CSA approved. Note that all other panels and equipment in Electrical Rooms shall be "Sprinkler Proof" as noted in the Contract Documents.
- .4 Bus and connections shall be copper, supported and braced to withstand short-circuit stresses in excess of main breaker rating (50 KA SYM minimum).
- .5 Structures shall consist of metal enclosed steel frame and front enclosures, which shall include separate compartments for each breaker and metering section. All joints of buses shall have tin-plated high pressure contacts and flame retardant bus supports.
- .6 A ground bus shall be provided bolted to each unit.
- .7 Provide bus extensions for connection to outgoing feeders and provide adequate space to suit connections to outgoing cables. Compression indent type terminals shall be used for all cable connections.
- .8 Provide suitable worded engraved plastic laminate nameplates for each device and compartment.
- .9 Provide all necessary fuses, fuse mounts, disconnect switches, small wiring, terminal blocks, and the like, as required for metering and relaying accessories as detailed.
- .10 The switchgear shall be completely assembled, wired and tested at the factory. After assembly, the complete switchgear shall be tested for operation under simulated service conditions to assure the accuracy of the wiring and functioning of the equipment.
- .11 The manufacturer shall provide necessary drawings prior to assembly of the equipment for approvals and provide final drawings upon completion of fabrication.
- .12 The entire structure shall be thoroughly cleaned and phosphated prior to application of the primary and finishing coats of paint.
- .13 Main 120/208 volt switchboard / Splitter - to contain generally as detailed on the Drawings and as follows:
 1. 200 ampere, 3 pole, 208 volt Main Bus - full capacity neutral with provisions for incoming bus and cables.
 2. Main breaker to comprise 200A/200AT amp fixed moulded case circuit breaker, 100% rated, solid state trip unit, for metered distribution. Interrupting rating shall be 50 KA-Symmetrical minimum.

3. Metering compartment for Supply Authority's transformers with hinged door complete with sealing and padlock provisions. Provide removable mounting pan within compartment for mounting of transformers. These provisions shall be submitted to and approved by the Supply Authority before manufacture.
4. Distribution Sections - Distribution Sections have 400 ampere main bus and full capacity neutral and circuit breakers with coordinated fault and trip ratings to suit main and distribution switches.
5. Auxiliary Customer Metering Compartments which shall include:
 - .1 Power Logic Digital Metering system capable of displaying voltage, current, KVA, KVAR, KW, PF, HZ, and the accumulated MWH, and KW demand. It shall be capable of continuously monitoring and storing minimum values of volts and PF and maximum values of amps., - KW-KVA-KVAR-KWS. All minimum/maximum values can be displayed. KYZ Pulse output to BMS. 1pulse=1kwh. Ethernet communications interface and all hardware/software. Field server RS232 to Ethernet Gateway and BACnet drivers for Ethernet and IP interface to BMS.
 - .2 All necessary instrument current and potential transformers and control protection devices.
6. The neutral conductor of the wiring system together with the conduit and service grounding system shall be bonded to the water service as detailed and in accordance with the Local Hydro Authority requirements.
7. All access to unmetered bus to be provided with bolted panels and provisions for sealing and padlocking.
8. Switchboard / Main Splitter shall be provided c/w 200 kA TVSS surge protection system.

3. EXECUTION

3.1 SECONDARY DUCT BANKS

- .1 Provide underground secondary duct bank as detailed to provide for installation of secondary cables. Construction details and exact location of terminations shall be verified on the site prior to installation commencing. Entire installation shall meet OESC requirements and local ESA Inspector's approval.
- .2 Provide warning tapes for secondary duct banks as per latest OESC code & bulletins.
- .3 Provide a secondary duct bank constructed to OESC approval comprising PVC Class 1 CSA approved ducts with minimum internal diameter of 104 mm (4 inches), buried to a depth as indicated on the Drawings to provide cover over the duct run. Ducts shall be laid parallel, spaced 152 mm (6") on centre horizontally and vertically, encased throughout their length in concrete, with a minimum cover of 76 mm (3") on all sides. The duct shall be on even grade, sloped not less than 76 mm (3") in 30 mm (100 feet). The duct bank enclosure shall be steel reinforced as detailed. Provide Bell ends for all ducts.
- .4 Provide in each duct a 5/16" (8 mm) polypropylene Draw Rope, to facilitate the cable installation.
- .5 The ducts shall be encased in a concrete envelope which shall be worked below and between ducts to provide a homogenous mass. Duct spacers shall be plastic to provide required spacing both horizontally and vertically. Minimum of two spacers per 3050 mm (10 ft.) length of duct shall be used.

3.2 GROUNDING

- .1 Provide a grounding system at the transformer and switchgear in accordance with OESC. Provide #2/0 AWG copper conductor connected to building ground system.
- .2 All work in connection with the pole mounted transformer shall be performed in strict accordance with regulations and the OESC. Obtain approval of all details before commencing work.

3.3 ELECTRICAL SERVICE

- .1 Provide complete electrical service as shown on the Drawings and as further described here.
- .2 The Local Hydro Authority will supply electrical service at 208 volt, 3 phase, 4 wire, 60 cycles.
- .3 Grounding service, equipment, feeders, and the like shall be performed in accordance with the Local Hydro Authority requirements.

The neutral conductor of the wiring system together with the conduit system and service equipment shall be bonded to the water service as near as practical to the service entrance. Confirm type of water service pipe system with Mechanical Division and provide grounding system in accordance with O.H.E.P.C. regulations.

Provide an "Artificial Grounding" system in accordance with Canadian Electric Code, Section 10-702 and Ontario Hydro Supplement. Location shall be to approval of the Supply & Inspection Authority requirements.

- .4 Install an outdoor P-base metering cabinet as per requirements and connected to switchboard with an empty 1-1/4" rigid conduit and telephone line all to approval of the Local Hydro Authority.

3.4 SECONDARY CABLES

- .1 Secondary cables c/w termination lugs (coordinate with the Local Hydro Authority for more information regarding termination lugs requirement at transformer secondary side and comply accordingly) shall be supplied and installed by the electrical Subcontractor.

3.5 HYDRO STANDARDS / REQUIREMENTS

- .1 Coordinate on site with the Local Hydro Authority representative for more information and details regarding hydro standards and requirement and exact scope of work prior to commencing the work and comply accordingly.

END OF SECTION

SECTION
SPECIFICATIONS: GENERATOR SET

1. Scope of Work

- 1.1. It is the intent of this specification to secure an engine-driven generator set that has been prototype tested, factory built, production-tested, and site-tested together with all accessories necessary for a complete installation as shown on the plans and the Drawings and specified herein.
- 1.2. Any and all exceptions to the published specifications shall be subject to the approval of the Consultant.
- 1.3. The power system shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and testing of the complete system. The entire system shall be installed as shown on the plans, the Drawings, and specifications herein.
- 1.4. The equipment 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.
- 1.5. The equipment shall be produced by a manufacturer who is ISO 9001 certified for the design, development, production and service of its complete product line.

2. General Requirements

- 2.1. It is the intent of this specification to secure a generator set system that has been tested during design verification, in production, and at the final job site. The generator set will be a commercial design and will be complete with all of the necessary accessories for complete installation as shown on the plans, drawings, and specifications herein. The equipment supplied shall meet the requirements of the Ontario Electrical Code and applicable local codes and regulations.
- 2.2. All equipment shall be new and of current production by a firm that manufactures the generator sets and controls, transfer switches, and switchgear, and assembles the generator sets as a complete and coordinated system. There will be one-source responsibility for warranty, parts, and service through a local representative with factory-trained servicemen.

3. Submittal

- 3.1. The submittal shall include prototype test certification and specification sheets showing all standard and optional accessories to be supplied; schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required interconnection between the generator set, the transfer switch, and the remote annunciator panel if it is included elsewhere in these specifications.

4. Codes and Standards

- 4.1. The generator set shall be listed to UL 2200 or submitted to an independent third party certification process to verify compliance as installed.
- 4.2. The generator set shall conform to the requirements of the following codes and standards:
 - 4.2.1. CSA C22.2, No. 14-M91 Industrial Control Equipment.
 - 4.2.2. EN50082-2, Electromagnetic Compatibility-Generic Immunity Requirements, Part 2: Industrial.
 - 4.2.3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
 - 4.2.4. IEC8528 part 4, Control Systems for Generator Sets.

- 4.2.5. IEC Std 61000-2 and 61000-3 for susceptibility, 61000-6 radiated and conducted electromagnetic emissions.
- 4.2.6. IEEE446 Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
- 4.2.7. CSA-C282-09 Emergency Electrical Power Supply for Buildings. The generator set shall meet all requirements of the specification including all alarms, shutdowns, and indications shown on Table-2 of the specification. The generator enclosure shall include dampers, heaters, emergency lighting, and a distribution panel in accordance with this specification.
- 4.2.8. CSA-149.1-10 Natural Gas and Propane Installation Code.

5. Testing

- 5.1. To ensure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer and/or local representative shall be responsible for three separate tests: design prototype tests, final production tests, and site tests.
- 5.2. **Design Prototype Tests.** Components of the emergency system, such as the engine/generator set, transfer switch, and accessories, shall not be subjected to prototype tests because the tests are potentially damaging. Rather, similar design prototypes and preproduction models shall be subject to the following tests:
 - 5.2.1. Maximum power (kW).
 - 5.2.2. Maximum motor starting (kVA) at 35% instantaneous voltage dip.
 - 5.2.3. Alternator temperature rise by embedded thermocouple and/or by resistance method per NEMA MG1-32.6.
 - 5.2.4. Governor speed regulation under steady-state and transient conditions.
 - 5.2.5. Voltage regulation and generator transient response.
 - 5.2.6. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
 - 5.2.7. Three-phase short circuit tests.
 - 5.2.8. Alternator cooling air flow.
 - 5.2.9. Torsional analysis to verify that the generator set is free of harmful torsional stresses.
 - 5.2.10. Endurance testing.
- 5.3. **Final Production Tests.** Each generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:
 - 5.3.1. Single-step load pickup
 - 5.3.2. Safety shutdown device testing
 - 5.3.3. Rated Power @ 0.8 PF
 - 5.3.4. Maximum power
 - 5.3.5. Upon request, a witness test, or a certified test record sent prior to shipment.
- 5.4. **Site Tests.** The manufacturer's distribution representative shall perform an installation check, start-up, and building load test. The Consultant, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:
 - 5.4.1. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present

and expected.

- 5.4.2. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include: block heaters, battery chargers, alternator strip heaters, remote annunciators, etc.
- 5.4.3. Generator set start-up under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during operation, normal and emergency line-to-line voltage and frequency, and phase rotation.
- 5.4.4. Automatic start by means of a simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator set voltage, amperes, and frequency shall be monitored throughout the test.

6. Warranty and Maintenance

- 6.1. The generator set shall include a standard one year warranty to guarantee against defective material and workmanship in accordance with the manufacturer's published warranty from date of start-up. Optional warranties shall be available upon request.
- 6.2. The generator set manufacturer and its distributor shall maintain a 24-hour parts and service organization. This organization shall regularly engage in maintenance contract programs to perform preventive maintenance and service on equipment similar to that specified. A service agreement shall be available and shall include system operation under simulated operating conditions; adjustment to the generator set, transfer switch, and switchgear controls as required, and certification in the owner's maintenance log of repairs made and function tests performed on all systems.

7. Equipment

- 7.1. The generator set shall be a Kohler model 60REZGB with a 4P7BX alternator or equivalent. It shall provide 60kW/75 kVA when operating at 120/208 volts, 60 Hz, .8 power factor. The generator set shall be capable of a Standby 130°C rating while operating in an ambient condition of less than or equal to 77° F and a maximum elevation of 656 feet above sea level.
- 7.2. Motor starting performance and voltage dip determinations shall be based on the complete generator set. The generator set shall be capable of supplying 135 LRKVA for starting motor loads with a maximum instantaneous voltage dip of 35%, as measured by a digital RMS transient recorder in accordance with IEEE standard 115. Motor starting performance and voltage dip determination that does not account for all components affecting total voltage dip i.e. engine, alternator, voltage regulator and governor will not be acceptable. As such, the generator set shall be prototype tested to optimize and determine performance as a generator set system.
- 7.3. Vibration isolators shall be provided between the engine-alternator and heavy-duty steel base.

8. Engine

- 8.1. The minimum 305-cubic-inch displacement engine shall deliver a minimum of 89 HP at a governed engine speed of 1800 rpm, and shall be equipped with the following:
 - 8.1.1. Electronic isochronous governor capable of 0.5% steady-state frequency regulation. Engine speed shall be nominally 1800 rpm. Engines running at higher rpm's and featuring speed reduction gear drives are not acceptable.
 - 8.1.2. 12-volt positive-engagement solenoid shift-starting motor.
 - 8.1.3. 70-ampere automatic battery charging alternator with a solid-state voltage

regulation.

- 8.1.4. Positive displacement, full-pressure lubrication oil pump, cartridge oil filters, dipstick, and oil drain.
- 8.1.5. Dry-type replaceable air cleaner elements for normal applications.
- 8.1.6. Engine-driven or electric fuel-transfer pump including fuel filter and electric solenoid fuel shutoff valve capable of lifting fuel.
- 8.2. The turbocharged engine shall be fueled by natural gas.
- 8.3. The engine shall have a minimum of 8 cylinders and be liquid-cooled by Unit Mounted Radiator 122°F/50°C.
- 8.4. The engine shall be EPA certified from the factory, and shall not require a site performance test.
- 8.5. Natural Gas fuel supply pressure, measured at the generator set fuel inlet downstream of any fuel system equipment accessories shall be within the operating range of 1.74-2.74 kPa (7.0-11.0 in. H₂O). Engines requiring higher gas pressures are not acceptable.

9. Alternator

- 9.1. The alternator shall be salient-pole, brushless, 2/3-pitch, 12 lead, self-ventilated with drip-proof construction and amortisseur rotor windings and skewed for smooth voltage waveform. The ratings shall meet the NEMA standard (MG1-32.40) temperature rise limits. The insulation shall be class H per UL1446 and the varnish shall be a fungus resistant epoxy. Temperature rise of the rotor and stator shall be limited to Standby 130°C. The excitation system shall be of brushless construction controlled by a solid-state voltage regulator capable of maintaining voltage within $\pm 2.0\%$ at any constant load from 0% to 100% of rating. The AVR shall be capable of proper operation under severe nonlinear loads and provide individual adjustments for voltage range, stability and volts-per-hertz operations. The AVR shall be protected from the environment by conformal coating. The waveform harmonic distortion shall not exceed 5% total RMS measured line-to-line at full rated load. The TIF factor shall not exceed 50.
- 9.2. The alternator shall have a single maintenance-free bearing, designed for 40000 hour B10 life. The alternator shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.
- 9.3. The generator shall be inherently capable of sustaining at least 250% of rated current for at least 10 seconds under a 3-phase symmetrical short circuit without the addition of separate current-support devices.

10. Controller

- 10.1. **Decision-Maker® 550 Controller**
 - 10.1.1. The generator set controller shall meet CSA-C282-09 requirements and shall include an integral alarm horn as required by NFPA.
 - 10.1.2. The controller shall meet all alarms, shutdowns, and indication stipulated in Table 2 of the CSA-C282-09 specification.
 - 10.1.3. The controller shall be UL 508 listed.
 - 10.1.4. Controller shall have a key switch to meet local code requirements and shall be removable only in the AUTO position.
- 10.2. Applicability
 - 10.2.1. The controller shall be standard on a 60REZGB.
 - 10.2.2. The controller shall support 12-volt starting systems.
 - 10.2.3. The controller's environmental specification shall be: -40°C to 70°C operating

temperature range and 5-95% humidity, non-condensing.

- 10.2.4. The controller shall mount on the generator or remotely within 40 feet with viewable access.

10.3. Hardware Requirements

10.3.1. Control Panel shall include:

1. The control shall have a run-off/reset-auto three-position selector switch.
2. A controller-mounted, latch-type emergency stop pushbutton.
3. Five indicating lights: System Ready - green Not in Auto - yellow Programming Mode - yellow System Warning - yellow System Shutdown - red
4. Display with two lines of 20-alphanumeric characters, viewable in all light conditions.
5. Sixteen position snap action sealed keypad for menu selection and data entry.
6. For ease of use, an operating guide shall be printed on the controller faceplate.
7. An audible alarm with alarm silence capability.
8. Panel lights shall be supplied as standard.

10.4. Control Functional Requirements

- 10.4.1. Field-programmable time delay for engine start. Adjustment range 0-5 minutes in 1 second increments.
- 10.4.2. Field-programmable time delay engine cooldown. Adjustment range 0-10 minutes in 1 second increments.
- 10.4.3. Capability to start and run at user-adjustable idle speed during warmup for a selectable time period (0-10 minutes), until engine reaches preprogrammed temperature, or as supported by ECM-equipped engine.
- 10.4.4. The idle function including engine cooldown at idle speed.
- 10.4.5. Real-time clock and calendar for time stamping of events.
- 10.4.6. Output with adjustable timer for an ether injection starting system. Adjustment range, 0-10 seconds.
- 10.4.7. Output for shedding of loads if the generator set reaches a user programmable percentage of its kW rating. Load shed shall also be enabled if the generator set output frequency falls below 59 Hz.
- 10.4.8. Programmable cyclic cranking that allows up to six crank cycles and up to 35 seconds of crank time per crank cycle.
- 10.4.9. The capability to reduce controller current battery draw, for applications where no continuous battery charging is available. The controller vacuum fluorescent display should turn off automatically after the controller is inactive for 5 minutes.
- 10.4.10. Control logic with alternator protection for overload and short circuit matched to each individual alternator and duty cycle.
- 10.4.11. Control logic with RMS digital voltage regulation. A separate voltage regulator is not acceptable. The digital voltage regulator shall be applicable to single- or three-phase systems.
- 10.4.12. The capability to exercise the generator set by programming a running time into

the controller. This feature shall also be programmable through the PC software.

- 10.4.13. Control function shall include output voltage adjustment.
- 10.4.14. Battle switch function selection to override normal fault shutdowns, except emergency stop and overspeed shutdown.
- 10.4.15. The control shall detect the following conditions and display on control panel:
 - 1. Customer programmed digital auxiliary input ON (any of the 21 inputs available)
 - 2. Customer programmed analog auxiliary input out of bounds (any of 7 inputs for ECM equipped engines and 5 inputs for non ECM engines)
 - 3. Emergency stop
 - 4. High & low coolant temperature
 - 5. High oil temperature
 - 6. Controller internal fault
 - 7. Locked rotor - fail to rotate
 - 8. Low coolant level
 - 9. Low oil pressure
 - 10. Master switch error
 - 11. CSA-C282-09 common alarm
 - 12. Overcrank
 - 13. Overspeed with user-adjustable level, range 60-70 Hz.
 - 14. Overvoltage with user adjustable level, range 105% to 135%
 - 15. Overfrequency with user adjustable level, range 102% to 140%
 - 16. Underfrequency with user adjustable level, range 80% to 90%
 - 17. Undervoltage with user adjustable level, range 70% to 95%
 - 18. Coolant temperature signal loss
 - 19. Oil pressure gauge signal loss

Conditions resulting in generator warning (generator will continue to operate):

- 1. Battery charger failure
- 2. Customer programmed digital auxiliary input on (any of the 21 inputs available)
- 3. Customer programmed analog auxiliary input on (any of the 7 inputs available on ECM engines and 5 inputs for non ECM engines)
- 4. Power system supplying load
- 5. Ground fault detected - detection by others
- 6. High battery voltage - Level shall be user adjustable.
- 7. Range 29-33 volts for 24-volt systems.
- 8. High coolant temperature
- 9. Load shed

10. Loss of AC sensing
11. Underfrequency
12. Low battery voltage - level shall be user adjustable, range 20-25 volts for 24-volt systems.
13. Low coolant temperature
14. Low fuel level or pressure
15. Low oil pressure
16. CSA-C282-09 common alarms
17. Overcurrent
18. Speed sensor fault
19. Weak battery
20. Alternator protection activated

10.5. Control Monitoring Requirements

- 10.5.1. All monitored functions must be viewable on the control panel display.
- 10.5.2. The following generator set functions shall be monitored:
 1. All output voltages - single phase, three phase, line to line, and line to neutral, 0.25% accuracy
 2. All single phase and three phase currents, 0.25% accuracy
 3. Output frequency, 0.25% accuracy
 4. Power factor by phase with leading/lagging indication
 5. Total instantaneous kilowatt loading and kilowatts per phase, 0.5% accuracy
 6. kVARS total and per phase, 0.5% accuracy
 7. kVA total and per phase, 0.5% accuracy
 8. kW hours
 9. A display of percent generator set duty level (actual kW loading divided by the kW rating)
- 10.5.3. Engine parameters listed below shall be monitored: (*available with ECM equipped engines)
 1. Coolant temperature both in English and metric units
 2. Oil pressure in English and metric units
 3. Battery voltage
 4. RPM
 5. Lube oil temperature*
 6. Lube oil level*
 7. Crankcase pressure*
 8. Coolant level*
 9. Coolant pressure*
 10. Fuel pressure*
 11. Fuel temperature*

- 12. Fuel rate*
- 13. Fuel used during the last run*
- 14. Ambient temperature*

10.5.4. Operational records shall be stored in the control beginning at system start-up.

- 1. Run time hours
- 2. Run time loaded hours
- 3. Run time unloaded hours
- 4. Number of starts
- 5. Factory test date
- 6. Last run data including date, duration, and whether loaded or unloaded
- 7. Run time kilowatt hours

10.5.5. The following operational records shall be a resettable for maintenance purposes:

- 1. Run time hours
- 2. Run time loaded hours
- 3. Run time unloaded hours
- 4. Run time kilowatt hours
- 5. Days of operation
- 6. Number of starts
- 7. Start date after reset

10.5.6. The controller shall store the last one hundred generator set system events with date and time of the event.

10.5.7. For maintenance and service purposes, the controller shall store and display on demand the following information:

- 1. Manufacturer's model and serial number
- 2. Battery voltage
- 3. Generator set kilowatt rating
- 4. Rated current
- 5. System voltage
- 6. System frequency
- 7. Number of phases

10.6. Inputs and Outputs

10.6.1. Inputs

- 1. There shall be 21 dry contact inputs that can be user-configured to shut down the generator set or provide a warning.
- 2. There shall be 7 user-programmable analog inputs for ECM-equipped engines (5 for non-ECM engines) for monitoring and control.
- 3. Each analog input can accept 0-5 volt analog signals
- 4. Resolution shall be 1:10,000

5. Each input shall include range settings for 2 warnings and 2 shutdowns.
6. All values shall be on the control panel display.
7. Shall be user-assigned.
8. Additional standard inputs required:
 - Input for an external ground fault detector. Digital display shall show "ground fault" upon detection of a ground fault.
 - Reset of system faults.
 - Remote two-wire start.
 - Remote emergency stop.
9. Idle mode enable.

10.6.2. Outputs

1. All CSA-C282-09 outputs shall be available.
2. Thirty outputs shall be available for interfacing to other equipment:
 - All outputs shall be user-configurable from a list of 25 functions and faults.
 - These outputs shall drive optional dry contacts.
3. A programmable user-defined common fault output with over 40 selections shall be available.

10.7. Communications

- 10.7.1. If the generator set engine is equipped with an ECM (engine control module), the controller shall communicate with the ECM for control, monitoring, diagnosis, and meet SAE J1939 standards.
- 10.7.2. Industry standard Modbus communication shall be available.
- 10.7.3. A Modbus master shall be able to monitor and alter parameters, and start or stop a generator.
- 10.7.4. The controller shall have the capability to communicate to a personal computer (IBM or compatible) running Windows '9X or Windows NT.
- 10.7.5. Communications shall be available for serial, CAN, and Ethernet bus networks.
- 10.7.6. A variety of connections shall be available based on requirements:
 1. A single control connection to a PC.
 2. Multiple controls on an intranet network connected to a PC.
 3. A single control connection to a PC via phone line.
 4. Multiple controls to a PC via phone line.
- 10.7.7. Generator and transfer switch controls shall be equipped with communications modules capable of connecting to the same communication network.
- 10.7.8. The capability to connect up to 128 controls (any combination of generator sets and transfer switches) on a single network shall be supported.
- 10.7.9. Cabling shall not be limited to the controller location.
- 10.7.10. Network shall be self-powered.

11. Accessories

- 11.1. **Air Restriction Indicator.** The air cleaner restriction indicator shall indicate the need for maintenance of the air cleaners.
- 11.2. **Battery Charger.** A 6-ampere automatic float to equalize battery charger with the following features:
 - 1. 12 VDC output
 - 2. 1% steady-state voltage regulation from no load to full load over 10% AC input line voltage variation
 - 3. LED lamps for charge state indication
 - 4. Temperature compensated for ambient temperatures for -40°C to 70°C
 - 5. Potting for durability
 - 6. Short-circuit and reverse polarity protection
 - 7. UL 1236 listed
- 11.3. **Battery Rack and Cables.** Battery rack and battery cables capable of holding the manufacturer's recommended batteries shall be supplied.
- 11.4. **Circuit Breaker.** The generator shall come with a primary, factory installed, 100% rated line circuit breaker of 200 amperes that is UL2200 listed. Line circuit breakers shall be sized for the rated ampacity of the genset. Load side lugs shall be provided from the factory. The line circuit breaker shall include auxiliary contacts, shunt trip, undervoltage trip, alarm switch, and overcurrent switch functionality. Load side breaker connections made at the factory shall be separated from field connections. When GFI breakers are required, additional neutrals shall be factory installed.
- 11.5. **Dry Contact Kits.** The 10 Dry Contact Kit shall provide normally open and normally closed, gold-plated contacts in a form C configuration to activate warning devices and other customer-provided accessories allowing remote monitoring of the generator set. Typically, lamps, audible alarms, or other devices signal faults or status conditions.
- 11.7. **Failure Relay.**
 - 11.7.1. The common failure relay shall remotely signal auxiliary faults, emergency stop, high engine temperature, low oil pressure, overcrank, and overspeed via one single-pole, double-throw relay with 10 amps at 120 VAC contacts.
 - 11.7.2. The relay contacts shall be gold flashed to allow use of low current draw devices (100ma @ 28VDC min.).
 - 11.7.3. Once energized the relay shall remain latched until the system is reset by the main controller switch.
- 11.8. **Remote Annunciator Panel.** The remote annunciator shall meet CSA-C282-09 Table 2 requirements and enable remote viewing of the generator status. The panel shall be connected to the generator controller via either network communication wires or via hard wired connections. Options shall be available to provide ATS source availability, contactor position, and loaded or unloaded test for up to four transfer switches. The panel shall have the capability to be either flush- mounted or surface-mounted. The annunciator shall meet UL508 requirements.
- 11.9. **Rodent Guards.** Generator rodent guards shall prevent intrusion and protect internal components.
- 11.10. **Run Relay.** The run relay shall provide a three-pole, double-throw relay with 10-amp/ 250 VAC contacts to indicate that the generator is running. The relay provides three sets of dry contacts for energizing or de-energizing customer devices while the generator is running

(e.g. louvers, indicator lamps, etc.)

- 11.11. **Skid End Caps.** The generator shall include skid end caps.
- 11.12. **Standard Air Cleaner.** The air cleaner shall provide engine air filtration which meets the engine manufacturer's specifications under typical operating conditions.
- 11.13. **Block Heater.** The block heater shall be thermostatically controlled and sized to maintain manufacturers recommended engine coolant temperature to meet the start-up requirements of CSA-C282-09.

12. Sound Enclosure

- 12.1. The enclosure shall be constructed from high strength, low alloy steel, aluminum or galvanized steel.
- 12.2. The enclosure shall be finish coated with powder baked paint for superior finish, durability and appearance. Enclosures will be finished in the manufacturer's standard color.
- 12.3. The enclosure shall allow the generator set to operate at full load in an ambient of 40°C - 45°C with no additional de-rating of the electrical output.
- 12.4. The enclosure shall be equipped with sufficient side and end doors to allow access for operation, inspection, and service of the unit and all options. Minimum requirements are two doors per side. When the generator set controller faces the rear of the generator set, an additional rear facing door is required. Access to the controller and main line circuit breaker must meet the requirements of the Ontario Electric Code.
- 12.5. Doors shall be equipped with lockable latches. Locks must be keyed alike.
- 12.6. A duct between the radiator and air outlet shall be provided to prevent re-circulation of hot air.
- 12.7. The complete exhaust system shall be internal to the enclosure.
- 12.8. All acoustical insulation shall be fixed to the mounting surface with pressure sensitive adhesive or mechanically fastened. In addition, all acoustical insulation mounted on a horizontal plane shall be mechanically fastened. The acoustical insulation shall be flame retardant.
- 12.9. The enclosure shall include an exhaust scoop to direct the cooling air in a vertical direction.
- 12.10. The enclosure shall include a mounted load centre to be fed from the buildings normal electrical supply. The load centre shall include individual feeder breakers pre-wired to all engine and enclosure electrical devices requiring normal supply power including, but not limited to: block heater, battery heater, battery charger, enclosure space heater, enclosure dampers, and 2-hour battery back-up emergency light pack (as specified in CSA-C282-09).
- 12.11. The enclosure dampers and space heater shall be configured so as to keep the interior space of the enclosure at 10°C at all times when the engine is not running. Dampers shall be installed in a fail-safe to open configuration. The dampers shall be configured to open upon failure of normal power. Dampers shall also be configured to open upon engine running, regardless of the condition of normal supply power.
- 12.12. If the plans show the generator is not being installed on a solid concrete pad and will be elevated in any way such the bottom of the generator set enclosure will be open to the elements, provide a solid sheet metal bottom to the enclosure. The solid bottom shall be installed in such a way that it does not compromise the enclosure heating, engine cooling, or sound emissions of the unit, while also preventing rodent intrusions.

END OF SECTION

1. GENERAL

1.1 SUMMARY

- A This section includes the following items from a single supplier:
 - 1. Automatic transfer switch
 - 2. Related Accessories as specified
- B Products Furnished or Supplied but not installed
- C Products Installed but not furnished or supplied
- D Related Requirements
 - 1. It is the intent of this specification to secure an automatic transfer switch that has been prototype tested, factory built, production-tested, and site-tested together with all accessories necessary for a complete installation as shown on the plans and drawings and specified herein.
 - 2. It is the intent of this specification to secure an automatic transfer switch that has been tested during design verification, in production, and at the final job site. The automatic transfer switch will be a commercial design and will be complete with all of the necessary accessories for complete installation as shown on the plans, drawings, and specifications herein. The equipment supplied shall meet the requirements of the National Electrical Code and applicable local codes and regulations.
 - 3. All equipment shall be new and of current production by an international, power system manufacturer of generators, transfer switches, and paralleling switchgear. The manufacture shall be a supplier of a complete and coordinated system. There will be single-source responsibility for warranty, parts, and service through a factory-authorized representative with factory-trained technicians.

1.2 SUBMITTALS

- A Action Submittals
 - 1. Product Data
 - a The submittal shall include specification sheets showing all standard and optional accessories to be supplied; schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required interconnection between the generator set, the transfer switch, and the remote annunciator panel if it is included elsewhere in these specifications.
 - 2. Shop Drawings
 - 3. Samples
- B Informational Submittal
 - 1. Certificates
 - 2. Test and Evaluation Reports
 - 3. Manufacturer's Instruction
 - 4. Source Quality Control Submittals
 - 5. Field or Site Quality Control
 - 6. Manufacturer's Report
 - 7. Special Procedure Submittal
 - 8. Qualification Statement
- C Closeout Submittals
 - 1. Maintenance Contracts
 - 2. Operation And Maintenance Data
 - 3. Bonds
 - 4. Warranty Documentation
 - 5. Record Documentation
 - 6. Software

- D Maintenance Material Submittals
 - 1. Literature
 - 2. Spare Parts
 - 3. Extra Stock Materials
 - 4. Tools

1.3 Quality Assurance

- A Regulatory Agency
 - 1. The automatic transfer switch shall conform to the requirements of the following codes and standards:
 - a UL 1008 - Standard for Transfer Switch Equipment
 - b IEC 947-6-1 Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
 - c NFPA 70 - National Electrical Code
 - d CSA-C282 (current edition) Emergency Electrical Power Supplies for Buildings
 - e IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - f NEMA Standard ICS 10-2005, Electromechanical AC Transfer Switch Equipment.
 - g EN61000-4-4 Fast Transient Immunity Severity Level 4
 - h EN61000-4-5 Surge Immunity Class 4 (voltage sensing and programmable inputs only)
 - i IEEE 472 (ANSI C37.90A) Ring Wave Test
 - j IEC Specifications for EMI/EMC Immunity (CISPR 11, IEC 1000-4-2, IEC 1000-4-3, IEC 1000-4-4, IEC 1000-4-5, IEC 1000-4-6, IEC 1000-4-8, IEC 1000-4-11)
 - k CSA C22.2 No. 178 certification
 - 2. Qualifications
 - a The automatic transfer switch shall be produced by a manufacturer who is ISO 9001 certified for the design, development, production and service of its complete product line.
 - b 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 shall produce the automatic transfer switch.
 - 3. Manufactures
 - a The automatic transfer switch shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and testing of the complete system. The entire system shall be installed as shown on the plans, drawings, and specifications herein.
 - b The manufacturer shall maintain a national service organization of employing personnel located throughout Canada. The Service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
 - c The manufacture shall maintain records of each switch, by serial number, for a minimum of 20 years.

1.4 Delivery, Storage, and Handling

- A Delivery and Acceptance Requirements refer to 01 60 00.
- B Storage and Handling Requirements refer to 01 60 00.
- C Packaging Waste Management refer to 01 74 19.

1.5 Field or Site Conditions

- A Ambient Conditions
 - 1. Automatic transfer switch shall operate in the following conditions without any damage to the unit or its loads.

- a Ambient Temperature: -4 to 158 Degrees F
- b Relative Humidity: 5% to 95% noncondensing

B Existing Conditions

1.6 Warranty or Bond

A Manufacture Warranty

- 1. The ATS shall include a standard warranty covering two (2) years or 2000 hours, whichever occurs first, to guarantee against defective material and workmanship in accordance with the manufacturer's published warranty from the date of initial startup.
- 2. The ATS manufacturer and its distributor shall maintain a 24-hour parts and service organization. This organization shall regularly engage in maintenance contract programs to perform preventive maintenance and service on equipment similar to that specified. A service agreement shall be available and shall include system operation under simulated operating conditions; adjustment to the generator set, transfer switch, and switchgear controls as required, and certification in the owner's maintenance log of repairs made and functional tests performed on all systems.

2. PRODUCTS

2.1 Equipment

A Equipment

- 1. Furnish and install an automatic transfer switches system(s) with 3-Pole / 4-Wire, Solid Neutral, 208V/60Hz. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer.

B Manufacture

- 1. Automatic transfer switches shall be Kohler Any Breaker Rated - Standard Transition (KCS)/KCS-DCTA-00. Any alternate shall be submitted for approval to the consulting engineer at least 10 days prior to bid date. Alternate bids shall include a line-by-line clarification of the specification marked with "D" for deviation; "E" for exception, and "C" for comply.
- 2. The ATS shall be the same manufacture as the generator set for maximum compatibility and single-source supply.

C Construction

- 1. The transfer switch shall be electrically operated and mechanically held with double throw construction, and operated by a momentarily energized solenoid-driven mechanism. Main operators shall include overcurrent disconnect devices; linear motors or gears shall not be acceptable.
- 2. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
- 3. The switch shall be positively locked and unaffected by momentarily outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- 4. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
- 5. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 800 amperes and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

6. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.
7. For two and three pole switches, where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.
8. For four pole switches with a switching neutral, where neutral conductors must be switched as shown on the plans, the contactor shall be provided with fully rated switched neutral transfer contacts. Overlapping neutral contacts may be used as an alternative.

D Enclosure

1. The ATS shall be furnished in a NEMA 1 enclosure.
2. All standard door mounted switches and indicating LEDs shall be integrated into a flush-mounted, interface membrane or equivalent in the enclosure door for easy viewing & replacement. The panel shall be capable of having a manual locking feature to allow the user to lockout all membrane mounted control switches to prevent unauthorized tampering. This cover shall be mounted with hinges and have a latch that may be padlocked. The membrane panel shall be suitable for mounting by others when furnished on open type units.

2.2 Operation

A Operators

B Controls

1. A four line, 20 character LCD display and dynamic 4 button keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and control through the communications interface port or USB. The following parameters shall only be adjustable via a password protected programming on the controller:
 - a Nominal line voltage and frequency
 - b Single or three phase sensing
 - c Operating parameter protection
 - d Transfer operating mode configuration (Standard transition, Programmed transition, or Closed transition)

C Voltage and Frequency

1. Voltage (all phases) and frequency on both the normal and emergency sources shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

a	Parameter	Dropout/Trip	Pickup/Reset
b	Under voltage	75 to 98%	85 to 100%
c	Over voltage	106 to 135%	95 to 100% of trip
d	Under frequency	95 to 99%	80 to 95%
e	Over frequency	01 to 115%	105 to 120%
f	Voltage unbalance	5 to 20%	3 to 18%
2. Repetitive accuracy of all settings shall be within $\pm 0.5\%$ over an operating temperature range of -20°C to 70°C.
3. An adjustable dropout time for transient voltage and frequency excursions shall be provided. The time delays shall be 0.1 to 9.9 seconds for voltage and .1 to 15 seconds for frequency.
4. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad, remotely via the communications interface port or USB.
5. The controller shall be capable of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or BAC). Unacceptable phase rotation shall be indicated on the LCD; the

service required LED and the annunciation through the communication protocol and dry contacts. In addition, the phase rotation sensing shall be capable of being disabled, if required.

6. The controller shall be capable of detecting a single phasing condition of a source, even though a voltage may be regenerated by the load. This condition is a loss of phase and shall be considered a failed source.
7. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases (phase to phase and phase to neutral), frequency, and phase rotation.

D Time Delays

1. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 12 or 24 VDC power supply.
2. A time delay shall be provided on transfer to the emergency source, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
3. A time delay shall be provided on re-transfer to normal. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
4. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
5. A time delay activated output signal shall also be provided to drive external relay(s) for selective load disconnect and reconnect control. The controller shall be capable of controlling a maximum of 9 individual output time delays to step loads on after a transfer occurs. Each output may be individually programmed for their own time delay of up to 60 minutes. Each sequence shall be independently programmed for transferring from normal to emergency and transferring from emergency to normal.
6. All time delays shall be adjustable in 1 second increments.
7. All time delays shall be adjustable by using the display and keypad, with a remote device connected to the communications interface port or USB.
8. Each time delay shall be identified and a dynamic countdown shall be shown on the display. Active time delays can be viewed with a remote device connected to the communications interface port or USB.

E Additional Features

F Operation Sequence

2.3 Materials

2.4 Assembly or Fabrication

- A Factory Assembly
- B Shop Fabrication
- C Assembly or Fabrication Tolerances

2.5 Mixes

2.6 Finishes

- A Primer Materials
- B Finish Materials
- C Shop Finishing Materials

2.7 Accessories

- A. Programmable Exerciser. A programmable exerciser shall be supplied to allow programming of up to 56 on/off events.

2.8 Source Quality Control

- A Test and Inspection

1. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
2. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

END OF SECTION

1.0 GENERAL

1.1 RELATED INSTRUCTIONS

- .1 Refer to Section 26 00 00 - Electrical General Requirements.

1.2 WORK INCLUDED

- .1 Provide electrical lighting fixtures and systems scheduled, complete with lamps, ballasts and necessary accessories required for their installation and performance.

1.3 LAMP AND BALLAST CONDITIONING

- .1 Upon first energizing all Lighting fixtures shall remain energized for a stabilizing period of 100 hours.

1.4 SHOP DRAWINGS

- .1 Submit for review a PDF-electronic copy containing illustrations of each fixture. Illustrations to be complete showing dimensions light distribution and mounting requirements. Illustrations to be noted to indicate special features and finishes. A copy is to be retained by the Contractor on the site, to ensure co-ordination of installation requirements.

2.0 PRODUCTS

2.1 REFERENCE NUMBERS

- .1 Catalogue reference numbers given for individual fixture types are intended as a guide when read with the description and the fixture as finally applied. Verify catalogue references with description and co-ordinated with installation conditions, with particular regard to ceiling construction details, type and finish before ordering fixtures.

2.2 BALLASTS

- .1 Programmable start high efficiency electronic fluorescent ballast, unless otherwise noted.
- .2 CSA and UL listed, Class P and type 1 outdoor, integrated electronic circuitry, less than 10% of voltage and frequency sustained variations with no damage to ballast. Less than 15% THD. Ballasts shall have an average lamp crest factor of less than 1.7. Ballast shall have frequency of operation in range 20-30 kHz or greater than 42KHz and operate without visible flicker. Power factor shall exceed 95%. No polychlorinated biphenyls (PCBs) will be permitted. Comply with ANSI C62.41 Category A for transient protection. Class A sound rating, -18°C (0°F) starting temperature, minimum 0.85 ballast factor. Meet FCC Standard for EMI/RFI.
- .3 Ballasts for compact fluorescent lamps shall be high power factor electronics c/w end of lamp life protection.
- .4 All ballasts shall be of single acceptable manufacturer, unless not feasible.
- .5 Acceptable ballast manufacturers are:

Philips Lighting
Osram Canada

or equivalent

2.3 LENSES

- .1 Plastic lenses in lighting fixtures shall be acrylic with minimum thickness of 3 mm (.125 inches) and, providing flame spread and smoke density ratings, complying with applicable Federal and Provincial Codes; Ontario Fire Marshal's Fire Safety Design Standard; and the Ontario Building Code.
- .2 Removable components of fixtures (louvres, lenses, wire guards, and the like) to be limited to maximum 1220 mm (48") in length.

2.4 NIL

2.5 FIXTURE SCHEDULE

- .1 See Drawings for lighting fixtures Schedule.
- .2 All LED lighting fixtures to come with dimming capability.

2.6 LED FIXTURES

Light Emitting Diode (LED) Systems:

- .1 LED systems shall be tested for performance in accordance with IES Standard LM78-08 and LM-80-08.
- .2 White LED's shall be of a Colour Temperature as stated in the luminaire description and colour rendering of no less than 70 for outdoor applications and no less than 80 for indoor applications.
- .3 LED's shall have a lumen maintenance rating of no less than L70 after 50,000 hours @25°C.
- .4 LED luminaires shall be warranted by the luminaire manufacturer as a complete system, Comprised of LED's, Drivers and Fixtures.
- .5 LED drivers and/or power supplies shall be suitable for 120V or 347V operation, as specified in fixture description, and have a Power Factor of >0.9 and THD of <20%.
- .6 LED luminaires shall be cUL, CSA and Energy Star Certified.
- .7 LED Systems shall be guaranteed for a period of 360 days from the date of Substantial Performance. Labour to install replacement luminaires or replacement parts shall be included in the guarantee.
- .8 Refer to fixture designations for detailed lamp characteristics (i.e. size, beam spread, etc.).
- .9 Acceptable Manufacturers:
 - .1 Philips Lighting
 - .2 Osram Sylvania
 - .3 Cree Canada
 - or equivalent

2.7 EMERGENCY LIGHTING SYSTEM

- .1 Provide Emergency Lighting Units and Wiring Systems as noted.
- .2 Emergency battery units shall be designed to provide emergency lighting for at least 30 minutes automatically upon failure of a normal power source. Upon restoration of the normal power, the battery unit shall be restored automatically to a charging condition. The charging cycle shall raise the battery to an equalized voltage and then electronically sense the full state of charge in the battery and return the battery to a lower float voltage.

The charger shall be regulated to a plus or minus 20 mV output for plus or minus 10% input voltage fluctuation. In order to extend battery life at ambience other than room temperature, the charger shall reduce the battery voltage by 4 mV per cell per °C rise in temperature and shall raise the battery voltage by 4 mV per

cell per °C reduction in temperature from a 20°C reference temperature. The unit shall be equipped with a phase loss and brown out protection circuit which shall turn on emergency lights when input voltage to the unit falls below 90 volts or 75% full voltage. The unit shall include a test switch, charge and on pilot lights which shall be light emitting diodes. The unit shall include a low voltage disconnect circuit.

- .3 Battery units shall be Lumacell of the types noted, complete maintenance-free, sealed pure lead Model No. RG24S series rated as indicated on the drawings with design life of 10 years, 24 volt. The unit shall be performance certified and carry C.S.A. C22.2 No. 141 approval for the wattage noted.
- .4 Wall mounted unit shall be provided with recessed back box and mounting template to allow pre-installation feeds of A.C. input and D.C. output. Both A.C. input and D.C. output shall enter unit through back face without any visible cable or conduit feeds. Provide wall mounted shelf for each battery unit.
- .5 Provide a 120 volt input circuit for each unit wired to unswitched circuit indicated. Wire to exit signs from battery units. Size conductors to all remote lamps to provide maximum voltage drop of five percent.
- .6 Emergency Equipment Types:

Type 1 - Shall comprise a Model MQM124V20W ceiling mounted adjustable MR16 remote lighting unit 20 watt 24 volt.

Type 2 - Same as Type 1 except double head, Model MQM224V20W.

Type 3 - Weatherproof model WP series, MR 16 20watt, 24 volts.

.7 Emergency Lighting Level Measurement

1. Include for services to measure and plot lighting levels on floor plans upon completion of work. Provide copies for review by Consultant and Fire Department.

.8 Exit Signs

1. Shall be Lumacell LA Series or equal, LED panel, extruded aluminum Pictogram Exit Signs, direction arrows as required, having less than 2.5 watts white LED panel for universal AC/DC connection. Weatherproof exit signs shall be Lumacell # LN Series as Pictogram exit signs

.9 Include for the supply, installation and wiring (to nearest normal & emergency lighting circuit) of 3 additional exit signs at locations later directed on site.

.10 Acceptable Emergency Equipment Manufacturers are:

- Lumacell
- Luxnet
- Emergi-lite
- Baghelli Canada Inc.
or equivalent

3.0 EXECUTION

3.1 INSTALLATION

- .1 Do not install or energize lamps until directed by Consultant which generally shall be just prior to occupancy of the building by the Owner. Read 'Temporary and Trial Usage'.

3.2 RECESSED FIXTURES

- .1 Provide plaster and/or framing rings for recessed fixtures (except for 'Lay-in Tee-Bar' types) the installation of which shall be the responsibility of this Section.
- .2 Recessed incandescent fixtures shall conform to requirements of latest bulletin of Electrical Safety Authority. Thermal insulation and combustible materials shall be kept clear of recessed fixtures.

3.3 COMPLETION

- .1 Fixtures shall be clean at the time of final acceptance.

END OF SECTION

1. GENERAL

1.1 RELATED INSTRUCTIONS

- .1 Refer to Section 26 00 00 - Electrical General Requirements.
- .2 Section Includes:
 1. Digital Occupancy and Daylighting Control
 2. Emergency Lighting Control SYSTEM DESCRIPTION & OPERATION
- .3 The Lighting Control and Automation system as defined under this section covers the following equipment:
 1. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relays controllers with 0-10 volt control for ballasts (if applicable) and single relay application- specific plug load controllers.
 2. Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
 3. Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
 4. Digital Photosensors – Single-zone closed loop and multi-zone open loop daylighting sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylight harvesting.
 5. Configuration Tools – Handheld remote for room configuration provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send and receive of room variables and store of occupancy sensor settings. Computer software also customizes room settings.
 6. Handheld remotes for personal control – One-button dimming, two-button on/off, or five- button scene remotes provide control using infrared communications. Remote may be configured in the field to control selected loads or scenes without special tools.
 7. Digital Lighting Management (DLM) local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
 8. Network Bridge – provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS).
 9. Segment Manager – provides web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
 10. After installation of the lighting controls system, it has to be commissioned in accordance with ASHRAE90.1-2013 sub-section 9.4.3.

1.2 LIGHTING CONTROL APPLICATIONS

- .1 Meet the requirements of Ontario building Code and also ASHRAE 90.1- 2013.

provide an application of lighting controls as follows:

1. Space Control Requirements – Provide occupancy/vacancy sensors with Manual-ON functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy

sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner- mounted sensors and Manual-ON switches.

2. Bi-Level Lighting – Provide multi-level controls in all spaces except toilet rooms, storerooms, library stacks, or applications where variable dimming is used.
3. Daylit Areas – All luminaires within 15' of windows or within 7' of skylights (the daylit zone) shall be controlled separately from luminaires outside of daylit zones. Luminaires closest to the daylight aperture shall be controlled separately from luminaires farther from the daylight aperture, within the daylight zone.
4. Daytime setpoints for total ambient illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
5. Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings.
6. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

.2 Additional controls.

1. Provide occupancy/vacancy sensors for any enclosed office, conference room, meeting room, and training room. For spaces with multiple occupants or where line-of-sight may be obscured, provide ceiling- or corner-mounted with manual-on switches.
2. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four (4) pre-set lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to extinguish all lighting in the space.

1.3 SUBMITTALS

- .1 Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.
- .2 Shop Drawings:
 1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).
 2. Scale drawing for each area showing exact location of each sensor, room controller, and digital switch.
- .3 Product Data: Catalog sheets, specifications and installation instructions.
- .4 Include data for each device which:
 1. Indicates where sensor is proposed to be installed.
 2. Prove that the sensor is suitable for the proposed application.

1.4 QUALITY ASSURANCE

- .1 Manufacturer: Minimum 10 years experience in manufacture of lighting controls.

1.5 PROJECT CONDITIONS

- .1 Do not install equipment until following conditions can be maintained in spaces to receive

equipment:

1. Ambient temperature: 0° to 40° C (32° to 104° F).
2. Relative humidity: Maximum 90 percent, non-condensing.

1.6 WARRANTY

- .1 Provide a five year complete manufacturer's warranty on all products to be free of manufacturers' defects.

1.7 MAINTENANCE

- .1 Spare Parts:
 1. Provide 2 of each product to be used for maintenance.

2. PRODUCTS

2.1 MANUFACTURERS

- .1 Acceptable Manufacturer:
 1. WattStopper
 - a. System: Digital Lighting Management (DLM)
 2. Basis of design product: WattStopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:
 - a. WattStopper Digital Lighting Management (DLM)
 - b. Douglas Lighting Control
 - c. Light system by SensorSwitch
 - d. Or Equivalent
- .2 Substitutions:
 1. All proposed substitutions (clearly delineated as such) may be submitted by the Contractor after the Contract award in writing for approval by the Consultant. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
 2. By using pre-approved substitutions, the Contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The Contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS

- .1 Type PW: Manual-ON, Automatic-OFF passive infrared (PIR) wall switch occupancy sensor
Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper PW-100, PW-200, PW-103, PW-203 or equivalent.
- .2 Type UW: Manual-ON, Automatic-OFF ultrasonic wall switch occupancy sensor with
Furnish the Company's model which suits the electrical system parameters and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper UW-100, UW-200 or equivalent..
- .3 Type DW: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor
Furnish the Company's model which suits the electrical system parameters and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled; WattStopper DW-100, DW-200, DW-103, DW-203 or

equivalent..

2.3 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

- .1 Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.
- .2 Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 1. Digital calibration and pushbutton programming for the following variables:
 - a. Sensitivity – 0-100% in 10% increments
 - b. Time delay – 1-30 minutes in 1 minute increments
 - c. Test mode – Five second time delay
 - d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
- .3 One or two RJ-45 port(s) for connection to DLM local network.
- .4 Two-way infrared (IR) transceiver to allow remote programming through and held commissioning tool and control by remote personal controls.
- .5 Device Status LEDs including:
 1. PIR Detection
 2. Ultrasonic detection
 3. Configuration mode
 4. Load binding
- .6 Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
- .7 Manual override of controlled loads.
- .8 Units shall not have any dip switches or potentiometers for field settings.
- .9 Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- .10 WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC or equivalent.

2.4 DIGITAL WALL SWITCHES

- .1 Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening. Wall switches shall include the following features:
 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Red configuration LED on each switch that blinks to indicate data transmission.

4. Blue Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
- .2 Two RJ-45 ports for connection to DLM local network.
- .3 Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.
- .4 The following switch attributes may be changed or selected using a wireless configuration tool:
 1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 2. Individual button function may be configured to Toggle, On only or Off only.
 3. Individual scenes may be locked to prevent unauthorized change.
 4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 5. Ramp rate may be adjusted for each dimmer switch.
 6. Switch buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.
- .5 WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101 or equivalent.

2.5 HANDHELD REMOTE CONTROLS

- .1 Battery-operated handheld switches in 1, 2 and 5 button configurations for remote switching or dimming control. Remote controls shall include the following features:
 1. Two-way infrared (IR) transceiver for line of sight communication with DLM local network within up to 30 feet.
 2. Blue LED on each button confirms button press.
 3. Load buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.
 4. Inactivity timeout to save battery life.
- .2 A wall mount holster and mounting hardware shall be included with each remote control
- .3 WattStopper part numbers: LMRH-101, LMRH-102, LMRH-105 or equivalent.

2.6 ROOM CONTROLLERS

- .1 Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
 1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
 3. Device Status LEDs to indicate:
 - a. Data transmission

- b. Device has power
 - c. Status for each load
 - d. Configuration status
- .2 Quick installation features including:
 - 1. Standard junction box mounting
 - 2. Quick low voltage connections using standard RJ-45 patch cable
- .3 Plenum rated
- .4 Manual override and LED indication for each load
- .5 Dual voltage (120/277 VAC, 60 Hz)
- .6 Zero cross circuitry for each load.
- .7 On/Off Room Controllers shall include:
 - 1. One or two relay configuration
 - 2. Efficient 150 mA switching power supply
 - 3. Three RJ-45 DLM local network ports
 - 4. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. One relay configuration only
 - b. Automatic-ON/OFF configuration
 - 5. WattStopper product numbers: LMRC-101, LMRC-102, LMPL-101 or equivalent.
- .8 On/Off/Dimming enhanced Room Controllers shall include:
 - 1. Real time current monitoring
 - 2. One, two or three relay configuration
 - 3. Efficient 250 mA switching power supply
 - 4. Four RJ-45 DLM local network ports.
 - 5. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
 - 6. Optional Network Bridge for BACnet MS/TP communications (LMRC-3xx).
 - 7. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - a. Establish preset level for each load from 0-100%
 - b. Set high and low trim for each load
 - c. Set lamp burn in time for each load up to 100 hours
 - 8. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. One relay configuration only
 - b. Automatic-ON/OFF configuration
 - 9. WattStopper product numbers: LMRC-211, LMRC-212, LMRC-213, LMPL-201, LMRC-311, LMRC-312, LMRC-313 or equivalent.

2.7 DIGITAL PHOTOSENSORS

- .1 Digital photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Photosensors shall be interchangeable without the need for rewiring.
- .2 Digital photosensors include the following features:
 - 1. An internal photodiode that measures only within the visible spectrum, and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have

a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.

- a. Sensor light level range shall be from 1-10,000 footcandles (fc).
- b. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
- c. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling after they turn off.
- d. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a user-selectable minimum level.
- e. Optional programmable wall switch override to allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.
- f. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
- g. Red configuration LED that blinks to indicate data transmission.
- h. Blue status LED indicates test mode, override mode and load binding.
- i. Recessed switch to turn controlled load(s) ON and OFF.
- j. One RJ-45 port for connection to DLM local network.
- k. An adjustable head and a mounting bracket to accommodate multiple mounting methods and building materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.

.3 Closed loop digital photosensors include the following additional features:

1. An internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from bright sources outside of this cone.
2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
3. Automatically establishes setpoints following self-calibration.
4. A sliding setpoint control algorithm for dimming daylight harvesting with a "Day Setpoint" and the "Night Setpoint" to prevent the lights from cycling.
5. WattStopper Product Number: LMLS-400 or equivalent.

.4 Open loop digital photosensors include the following additional features:

1. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.
2. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.
3. A proportional control algorithm for dimming daylight harvesting with a "Setpoint" to be maintained during operation.
4. WattStopper Product Number: LMLS-500 or equivalent.

2.8 ROOM NETWORK (DLM Local Network)

.1 The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building. Digital room devices connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:

1. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
2. Simple replacement of any device in the network with a standard off the shelf unit

- without requiring commissioning, configuration or setup.
- 3. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
- 4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

2.9 CONFIGURATIONS TOOLS

- .1 A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface.
- .2 Features and functionality of the wireless configuration tool shall include:
 - 1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
 - 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 - 3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
 - 4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
 - 5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.
 - 6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.
- .3 WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100 or equivalent.

2.10 EMERGENCY LIGHTING

- .1 Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - 1. 120/277 volts, 50/60 Hz., 20 amp ballast rating
 - 2. Push to test button
 - 3. Auxiliary contact for remote test or fire alarm system interface
- .2 WattStopper Product Numbers: ELCU-100, ELCU-200 or equivalent.

2.11 LIGHTING CONTROL PANELS

- .1 Lighting Control Panels
 - 1. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:
 - a. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 – 8 relays, 1 – 24 relays and 6 four-pole contactors, or 1 – 48 relays and 6 four-pole contactors.
 - b. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
 - c. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction

shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:

- i. Removable, plug-in terminal blocks with screwless connections for all low voltage terminations.
- ii. Individual terminal block, override pushbutton, and LED status light for each relay.
- iii. Direct wired switch inputs associated with each relay and group channel shall support two- or three-wire, momentary or maintained contact switches or 24VDC input from occupancy sensors.
- iv. Automatic support for occupancy sensor sequence of operation. Direct wired low voltage inputs automatically reconfigure when connected to a WattStopper occupancy sensor head. Occupancy sensor shall switch lighting on and off during unoccupied periods but shall not turn lighting off during scheduled occupancy periods.
- v. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches and digital occupancy sensors.
- vi. Isolated contacts within each relay shall provide true relay state to the electronics. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems.
- vii. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
- viii. Group, channel, and pattern control of relays shall be provided through a simple keypad interface within the panel. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override pushbuttons and LED displays. Relay group status for each channel shall be provided through bi-color operation of the LED indicators. Solid red indicates that all relays in the group are on, solid green indicates that the group is in a mixed state, and blinking green indicates that the relays have blink warned and are currently timing out.
- ix. Each relay and channel terminal block shall provide a 24V pilot light signal. It shall be possible to configure the system for support for any Class 2 pilot light voltage with the use of an auxiliary power supply.
- x. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:

Electrical:

- 1) 20 amp ballast at 277V
- 2) 20 amp ballast at 347V
- 3) 20 amp tungsten at 120V
- 4) 20 amp resistive at 347V
- 5) 1.5 HP motor at 120V
- 6) 14,000 amp short circuit current rating (SCCR) at 347V

Mechanical:

- 1) Individually replaceable, ½" KO mounting with removable Class 2 wire harness.
 - 2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - 3) Dual line and load terminals each support two #14 – #12 solid or stranded conductors.
 - 4) Tested to 300,000 mechanical on/off cycles.
- xi. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

- xii. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
- xiii. Lighting control panels shall be WattStopper model LILM8, LILM24 or LILM48 as shown on the plans, or equivalent.

.2 BACnet[®] Based Digital Communications

1. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 master/slave token passing-based using the BACnet[®] protocol.
 - a. The panel shall have provision for an individual BACnet device ID. The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
 - b. The panel shall support MS/TP MAC addresses in the range of 0 – 127 and baud rates of 9600k, 38400k and 76800k bits per second.
 - c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 – 48. The state of each relay shall be readable and writable by the BAS via the object present value property.
 - d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 – 48.
 - e. The eight channel groups associated with the panel shall be represented by binary value objects in the instance range of 1 – 8. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the occupied mode. Commanding 0 or NULL shall put the relays into the unoccupied mode.
 - f. Setup and commissioning of the panel shall not require manufacturer-specific software or configuration tools of any kind. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the on-board LCD display and user keypad. Provide BACnet objects for panel setup and control as follows:
 - i. Binary output objects in the instance range of 1 – 48 (one per relay) for on/off control of relays.
 - ii. Binary value objects in the instance range of 1 – 8 (one per channel) for normal hours/after hours schedule control.
 - iii. Binary input objects in the instance range of 1 – 48 (one per relay) for reading true on/off state of the relays.
 - iv. Analog value objects in the instance range of 1 – 48 (one per relay) shall assign relays to channel groups in the range of 1 – 8.
 - v. Binary value objects in the instance range of 101 – 108 (one per channel group) shall assign the channel to follow auto-on or manual-on mode when transitioning to occupied.
 - vi. Analog value objects in the instance range of 101 – 108 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute gracetime period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
 - vii. Analog value objects in the instance range of 211 – 208 (one per channel) shall assign an after hours time delay value to the channel in the range of 1 – 240 minutes.
 - viii. Multi-state value objects in the instance range of 1 – 8 (one per

channel) shall provide the state of the relays assigned to the channel.
Valid states shall be ALL ON, MIXED, BLINK, and ALL OFF.

- g. The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
- h. The BO and BV objects shall support BACnet priority array with a relinquish default of off and after hours respectively.

.3 User Interface

- 1. Each lighting control panel shall be supplied with an integral user interface consisting of a keypad and associated OLED display screen. The user interface shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following functions as a minimum:
 - a. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
 - b. Enter meaningful names for the panel, relays, and channels.
 - c. View normal hours/after hours status of each channel.
 - d. Override the normal hours/after hours mode for each channel.
 - e. View the 16 priority array slots for each channel and relay.
 - f. Program the schedule response for each channel as:
 - i. Automatic-on or manual-on.
 - ii. Enable/disable blink warn.
 - iii. Enter override time delay as 0 (none) to 240 minutes.

.4 Schedule, Group, And Photocell Control Of Relays

- 1. The lighting control panel shall support schedule, group, and photocell control functions via the network as configured in the optional Segment Manager controller or building automation system. The lighting control panel shall be fully compatible with building automation systems that are BACnet compliant. See related specification sections for additional information on interfacing the lighting control panel(s) to the building automation system.

.5 Browser-Based Programming And Control

- 1. The digital segment manager shall be a compact controller capable of hosting the schedule, photocell, and group relay control functions for a network of up to 96 LILM series lighting control panels. The segment manager shall provide the following features:
 - a. Provision for 1 to 3 separate network segments to facilitate efficient network wire routing.
 - b. Compact housing with screw tab mounts for surface installation and integral DIN rail mounting slot for NEMA 1 installation in the LMSM-ENC1 enclosure.
 - c. Web browser-based user interface; shall not require the installation of any lighting control software.
 - d. User interface accessible from most smart phone browsers when Internet connected.
 - e. Login security access control restricting some users to view-only or other limited operations.
 - f. Automatic discovery of the lighting control panels.
 - g. Familiar navigation-tree-based browsing to individual lighting control panels.
 - h. View/override current status of channels and relays.
 - i. Assign relays to channels.
 - j. Set channel operating parameters:

- i. Automatic-on or manual-on operation.
 - ii. Enable/disable blink warn.
 - iii. Override duration time, 0 (none) to 240 minutes.
 - iv. AS-100 automatic wall switch operation mode.
- k. Create and run schedules:
 - i. Normal hours/after hours schedules for channels.
 - ii. On/off schedules for relays.
 - iii. Support for a minimum of 100 unique schedules, each with up to four time events per day.
 - iv. Support annual schedules, holiday schedules and unique date-bound schedules.
- l. Ethernet connectivity for user access via direct-wired connection, LAN/WAN, or Internet connection.
- m. BACnet IP connectivity for connection to building automation systems.
- n. Segment manager shall be WattStopper LMSM-201 with one network segment or LMSM-603 with support for three network segments or equivalent.

2.12 DIGITAL PHOTOCELL FOR OUTDOOR

- .1 Digital photocell for exterior lighting shall be Wattstopper #LMIO-301 or equivalent.

3. EXECUTION

3.1 INSTALLATION

- .1 When using wire for connections other than the DLM local network (Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements
- .2 Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
- .3 Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - 1. Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.
- .4 Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and day lighting set points.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- .5 Re-commissioning – After 30 days from occupancy re-calibrate all sensor time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Consultant of re- commissioning activity.

3.2 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 working days written notice of the system startup 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.

END OF SECTION

1. GENERAL

1.1 SUMMARY

- .1 This section of specification is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with general conditions, supplementary conditions of the Contract, and section 26 00 00 – Electrical General Requirements.
- .3 Provide labour, materials, and equipment for installation, testing, and commissioning of a complete operating fire alarm system as specified herein, indicated on drawings, add/or required otherwise. The system shall be left ready for continuous and efficient satisfactory operation.

1.2 REFERENCE

- .1 Comply with the requirements of the latest edition of the following:
 - .1 CAN/ULC-S524, Standard for the installation of Fire Alarm Systems.
 - .2 ULC/S525, Audible Signal Appliances for Fire Alarm Systems.
 - .3 CAN/ULC-S526, Visual Signal Appliances for Fire Alarm Systems.
 - .4 CAN/ULC-S527, Control Units for Fire Alarm Systems.
 - .5 CAN/ULC-S528, Manual Pull Stations for Fire Alarm Systems.
 - .6 CAN/ULC-S529, Smoke Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S530, Heat Actuated Fire Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S531 Smoke Alarms for Fire Alarm Systems.
 - .9 CAN/ULC-S533, Egress Door Security and Releasing Devices.
 - .10 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems
 - .11 CAN/ULC-S537, Standard for the Verification of Fire Alarm System Installations
 - .12 CAN/ULC-S541 – Speakers for Fire Alarm Systems
 - .13 CAN/ULC-S553 - Installation for Smoke Alarms

1.3 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 26 00 00 . Shop drawing shall include:
 - .1 Complete system riser diagram showing all devices, control equipment, circuits and wiring.
 - .2 Details of system operating sequence.
 - .3 Details and performance specifications for system control annunciation and peripherals.
 - .4 Details for devices.
- .2 Submit arrangement and wording of annunciators for fire alarm zone indications to local fire department and provide changes as requested. Submit document to local fire department to department's requirement.
- .3 Following completion of verification, and of acceptance of the installation by local fire department, submit the certification of the Fire Alarm system, together with detailed verification record sheets showing location of each device and all verification results.

- .4 Submit the operating and maintenance manual in accordance with section 16010, the manual shall include:
 - .1 Instructions for the operation of the fire alarm system.
 - .2 Instructions for the maintenance of the fire alarm system.
 - .3 Approved shop drawings with all the connections.

1.4 QUALIFICATIONS

- .1 Acceptable Manufacturers:
 - .1 SimplexGrinnel
 - .2 Edwards
 - .3 Notifier
 - .4 Mircomor equivalent.
- .2 Installer: Certified fire alarm installer with service facilities 100km of project.

2. PRODUCTS

2.1 SYSTEM DESCRIPTION

- .1 The fire alarm system shall be an OBC, single stage, zoned non-coded, semi-addressable, microprocessor based, electrically supervised system with all components listed by ULC and CSA.
- .2 The fire alarm system shall include, but not limit to:
 - .1 Fire alarm control panel (FACP).
 - .2 Initiating devices: Manual pull station, automatic smoke and heat detectors.
 - .3 Signal devices: audible and visual.
 - .4 Auxiliary devices.
 - .5 Initiating circuits, signal circuits (minimum two circuits) and auxiliary circuits.
 - .6 Power and circuit wiring.
- .3 System shall be electrically supervised in accordance with CAN/ULC S524.
- .4 Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new configuration download. To accommodate this capability, the download of a new Panel program will be transferred to a "secondary" configuration memory bank, while the Panel continues to function on the "primary" configuration memory bank.

- .5 History Logs: The system shall provide a means to recall alarms, supervisory and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- .6 Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
- .7 Non-interfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
- .8 A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
- .9 FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values. The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations. The FACP shall automatically indicate when an individual sensor needs cleaning.

2.2 SYSTEM OPERATION

- .1 Activation of any alarm initiating devices (sprinkler flow switch, manual pull station, heat detector, smoke detector, etc.) shall initiate the operations to occur as follows:
 - .1 All the audible signal devices sound the alarm tone throughout the building.
All the visual signal devices shall be activated.
 - .2 The zone of initiation device shall be displayed on the control panel.
 - .3 Central station shall be signaled automatically for the notification of fire department.
 - .4 Release door hold open devices.
 - .5 Transmit signals to enable the following functions:
 - .1 Fans shut down
 - .2 Pressurization fans start-up.
 - .3 Mag-locks release
 - .4 Fire doors and/or smoke control doors, to close and/or open.
 - .5 Elevators to commence the fire mode sequence.
 - .6 Independent fire suspension systems to commence the fire mode sequence.
 - .7 Other functions as required on the drawings.
- .2 After one (1) minute of alarm, the system could be manually silenced via the silencing switch on the control panel. A subsequent alarm shall re-activated signals.

- .3 The alarm condition shall be cleared only upon activation of the reset switch on the control panel.
- .4 Activation of supervised sprinkler devices or other auxiliary systems, i.e. supervisory valves, pressure switches, fire pump, generator supervised contacts, etc. shall initiate the following operations:
 - .1 The respective supervisory zone shall be displayed on the control panel.
 - .2 Activate an audible signal (steady tone) on control panel. The signal may be silenced via silencing switch on control panel.
 - .3 Activate a visual signal (indicator) on control panel.
 - .4 Transmit a general trouble signal to central station.
 - .5 The trouble condition shall be cleared only via reset switch.
- .5 Any open circuit, circuit ground fault, short circuit condition, circuit loss of power, loss of main system power, system standby power trouble and removal of any system component shall initiate the following system trouble condition operations:
 - .1 The respective supervisory zone shall be displayed on the control panel.
 - .2 Activate the system trouble indicator on control panel.
 - .3 Activate system trouble audible signal (steady tone) on control panel. The signals may be silenced via silencing switch on control panel.
 - .4 Transmit a general trouble signal to central station.
 - .5 The trouble condition shall be cleared when the cause is rectified.

2.3 FIRE ALARM CONTROL PANEL

- .1 Fire alarm control panel (FACP) shall provide power, annunciation, supervision and control for the system.
- .2 Recessed or semi-recessed sprinkler-proof enclosure with lockable hinged front door.
- .3 Alarm initiating circuits in accordance with the number of zone indicated on the Fire Alarm Schedules plus 20% spare space capacity for future expansion and for the quantity of field devices in accordance with the manufacturer's recommendations.
- .4 Minimum two (2) signal circuits in accordance with the manufacturer's recommendations, with provision for future signal circuits. Signal circuits shall not be loaded more than 80% in order to allow for future adjustment.
- .5 High intensity LEDs for each zone circuit with 20% spare capacity for future zones as indicated. Type labels per the Fire Alarm Schedule and to the requirements of authorities having jurisdiction.
- .6 Common control module with LCD or LED backlit two-line character display of system function with the following additional features:
 - .1 Trouble LED, buzzer, silence switch. 'Signals Silenced' LED.

- .2 'Power-On', 'Disable', 'Supervisory; and 'Alarm' LEDs.
- .3 'Ground Fault' and 'Loss of Normal Power' LED.
- .4 Test pushbutton.
- .5 Alarm reset buttons.
- .7 Individual trouble display for each detection and signal circuit.
- .8 Auxiliary or output point for:
 - .1 Signal to motor controls for fan system shut-down or smoke control operations. Relays shall have contacts rated at 15 amps, pilot duty. Provide control measure to manually operate (turn on and turn off) each motor from FACP.
 - .2 Transmission of signal to off-premises central monitoring station. Actual connection for this function will be the Owner.
 - .3 Signals to elevator controllers.
 - .4 Signals to maglock release and hold open devices.
 - .5 Transmission of signal to security system for F.A. monitoring.
 - .6 Other functions as required on the drawings.
 - .7 20% spare output points for future.
- .9 Operator interface keypad. Provide LCD display with wording to the Consultant's approval in accordance with Fire Alarm Schedule.
- .10 Coded terminal strips for external connections to signal circuits, initiating circuit, multiplex annunciators, etc.
- .11 Receipt of a signal from an alarm initiating device shall cause audible signals to sound for a full period whether or not a previous alarm has been silenced manually.
- .12 The necessary controls to ensure that a fire alarm signal is not initiated during under- voltage or over-voltage conditions caused by changeover from normal to emergency power supply and vice versa.
- .13 Provide the necessary hardware and software required to provide a proper system operation.
- .14 Provide main system power supply to operate the entire fire alarm system and power supply at 24 volts from a 120 VAC 60Hz input. The integral standby power shall consist of 24 volt dc sealed nickel-cadmium batteries or gell-cell batteries, automatic battery charger with power reversal protection, ammeter and voltmeter to monitor charge rate and battery voltage. Standby power requirements shall be in accordance with CAN/ULC-S524, Section 3.2, Power Supply. Battery capacity shall be sufficient to provide 24-hour supervision plus 60 minutes full alarm operation. Battery charger shall be capable of recharging batteries to 80% capacity in 24 hours.

2.4 SYSTEM DEVICES

.1 Manual Pull Stations

- .1 Manual pull stations shall be single stage, extruded aluminum, semi-flush or surface, red, pull activated, wall mounted in 102mm square Red box. At maglock doors, the station shall have a dual contact.
- .2 Where required, provide tamper proof, weatherproof clear shield complete with a battery operated warning horn.

.2 Heat Detectors

- .1 Combination fixed 57°C (135°F) and 8.3°C (15°F)/min rate-of-rise type, in all areas except where normal temperature fluctuations exceed 10°C (18°F)/min.
- .2 Fixed temperature 91°C (195°F) type, provided in areas with normal ambient temperature between 38°C (100°F) and 66°C (150°F).
- .3 Ceiling mounted in 102mm square outlet box.
- .4 Detector in elevator shaft to be complete with auxiliary relays and wired to elevator controller.

.3 Area Smoke Detectors

- .1 Photoelectric type ceiling smoke detector with the following features:
 - .1 Sensitivity read-out;
 - .2 Snap-in base;
 - .3 Visual indication of detector actuation.
- .2 Ceiling mounted in 102mm square outlet box.
- .3 Smoke detectors in elevator machine rooms, elevator lobbies of 1st floor and 2nd floor, and elsewhere indicated shall be provided with auxiliary relays, and wired to elevator controls for supplementary operation of elevators.
- .4 Smoke detectors required for door hold openers and fire automatic doors shall be provided with auxiliary relays, and wired to door hold openers.

.4 Duct-Mounted Smoke Detectors

- .1 Product Description: photoelectric type with the following features:
 - .1 Auxiliary SPDT relay contact for locate fan shutdown;
 - .2 Key-operated normal-reset-test switch.
 - .3 Duct sampling tubes extending width of duct.
 - .4 Visual indication of detector actuation.

- .5 Duct-mounted housing.
 - .6 Powered from fire alarm control panel.
 - .2 Provide remote alarm indication for duct mounted smoke detectors installed in concealed spaces. Ensure that all detectors are accessible for maintenance.
 - .3 Refer to Mechanical Drawings for duct sizes and air velocities to ensure that the proper quantity of detectors is provided to adequately monitor the cross-sectional area of the duct in accordance with manufacturer's recommendations. Coordinate the proper location and installation with Divisions 21, 22 and 23.
 - .4 Where duct-mounted smoke detectors are installed outdoors, provide weather-proof enclosure. Provide heater and power and manufacturer's instruction.
 - .5 Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
 - .6 Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
- .5 Addressable Circuit Interface Modules
- .1 Addressable Circuit Interface Modules: Modules shall be used for monitoring of non-addressable devices and/or circuit, and for control of evacuation indicating appliances and AHU systems.
 - .2 Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signalling line or a separate two-wire pair running from an appropriate power supply as required.
 - .3 There shall be the following types of modules:
 - .1 Type 1: Monitor Circuit Interface Module:
 - a) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.
 - b) For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.
 - .2 Type 2: Line Powered Monitor Circuit Interface Module
 - a) This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the

capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.

- b) This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.

.3 Type 3: Single Address Multi-Point Interface Modules

- a) This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
- b) This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
- c) This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

.4 Type 4: Line Powered Control Circuit Interface Module

- a) This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.

.5 Type 5: 4-20 mA Analog Monitor Circuit Interface Module

- a) This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.

.6 All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

.6 End-of-Line Devices

- .1 Mount end of line devices in box with last device or separate box wall mounted, adjacent to last device.
- .7 Horns:
 - .1 Temporal horns rated at 98 dba to 91dba at 3m, finished in red and operated on 24V DC. Mounted in 102mm square or single gang outlet box. High and Low field selectable sound output level setting.
- .8 Fire Alarm Strobe
 - .1 Provide surface wall mounted synchronized high strobe lights to indicate alarm condition.
 - .2 The strobe light shall consist of a xenon tube with red lens. 75cd to 110 cd flash intensity.
 - .3 Mounted in 102mm square or single gang outlet box.
- .9 Annunciator
 - .1 Annunciator shall form part of the control panel and contain necessary number of LED lights and LCD to display all alarm, trouble and control zones.
 - .2 The annunciator shall contain a lamp test switch, trouble buzzer, acknowledge push button, signal silencing push button and reset push button.
- .10 Passive Graphic
 - .1 Passive Graphic to be white back grounds with color lines and text. Show all F/A zone areas, stair and elevator shafts, interior walls and doors and sprinkler devices. Size graphic as required. Brushed aluminum trim with tempered glass front. Install passive graphic beside the control panel.

2.5 WIRING

- .1 Install all wiring in conduit.
- .2 Fire alarm system wiring shall be run in separate conduit.
- .3 Provide shielded wiring when recommended by the manufacturer's specifications.
- .4 Wires shall be CSA-FAS Type 105 copper conductor, 105°C rating, not less than 300V Wiring shall be sized not less than requirement of Section 32-100 of the Electrical Safety Code, Class 1 or Class 2 circuits as required, with screw-terminal wiring connections.
- .5 Stranded conductors with more than 7 strands shall be bunched-tinned or terminated in compression connectors.
- .6 Provide watertight fittings for conduits entering the top or sides of surface mounted terminal cabinets, annunciator transponders and control panels.

2.6 SPECIAL ENVIRONMENT

- .1 Devices shall be moisture-proof where located in moisture area. Devices shall be weather-proof where located outside.

- .2 Provide heater and power to heater including breaker and wiring, (break may not be shown on drawing), for devices located in cold area as required by manufacturer.
- .3 Where the devices located in cold and/ or hot area, locate addressable module in warm area, and conventional devices in cold and/ or hot area.
- .4 Provide tamper proof wire guard where indicated on drawings.

2.7 SMOKE ALARMS AND CARBON MONOXIDE DETECTORS

- .1 Smoke alarms, carbon monoxide detectors and their combinations shall not be connected to the fire alarm system.
- .2 Ceiling mounted ionization type smoke alarms shall be activated by the presence of combustion products. The unit shall contain dual ionization chambers (one for fire detection, one for reference), solid state "Power On" indicator, sensitivity test button, electronic for providing 85 dB at 3 meters output, and the unit shall operate from 120 volt ac power circuit. Where more than one (1) smoke alarm is provided in a suite, the operation of one smoke alarm shall operate the alarm of all other smoke alarms within the suite.
- .3 Ceiling mounted carbon monoxide detectors shall operate from a hard-wired 120 volt AC source. The detector's chemical sensor to respond to CO concentrations and when dangerous levels are reached, trigger an internal alarm rated at a minimum of 85 dB at 3 meters. Detector shall be complete with LED light to indicate unit is receiving power and test button. Where more than one detector is provided in a suite, the operation of one detector shall operate the alarm of all other CO detectors within the suite.
- .4 Ceiling mounted combination smoke alarm and carbon monoxide detectors shall be activated by the presence of combustion products and the dangerous levels of CO concentration. The unit shall contain ionization chamber and chemical CO sensor, two visual alarm icons, alarm sound level of minimum 85 dB at 3 meters, "POWER ON" indicator, test/reset button, and the unit shall operate from 120 VAC power circuit. Where more than one unit is provided in a suite, the operation of one unit shall operate the alarm of all other units within the suite.

3. EXECUTION

3.1 INSTALLATION

- .1 Equipment
 - .1 Install all equipment in accordance with CAN/ULC-S524 "Standard for the Installation of Fire Alarm Systems", the manufacturer's instructions, Ontario Building Code, Underwriter's Laboratory of Canada, Electrical Safety Code, these Documents and requirements of the Authority Having Jurisdiction. This shall include appropriate settings for speaker transformer taps.
 - .2 In the event that the information given in the Specification and/or shown on the Drawings is in conflict with the Code and/or the requirement of the Authorities Having Jurisdiction, bring this to the attention of the Consultant, and do not proceed with the work until the matter is clarified.
- .2 Connections to Other Systems

- .1 Sprinkler and Fire Standpipe System Connections
 - .1 Provide wiring and connections to all flow switches, supervised valves and pressure switches supplied by Divisions 21, 22 and 23.
 - .2 Provide wiring and connections to sprinkler and fire standpipe pumps equipped with supervisory contacts provided by Divisions 21, 22 and 23 for 'Loss of Power', 'Phase Reversal' and 'Pump(s) Running' indications.
- .2 Motor Control Connections
 - .1 Provide all wiring and connections from the fire alarm system to motor starters as required for shut-down and/or start-up. Co-ordinate connection and location with Divisions 21, 22 and 23 for proper system operation.
 - .2 Wiring for local fans operation on smoke condition shall be installed by the electrical Subcontractor from duct mounted smoke detectors to the terminal panel adjacent to the motor control panel or the starter.
- .3 Door Device Connections
 - .1 Provide power, wiring, conduit and connections to electrical door hardware, door hold-open devices and door control (Maglocks) devices for proper release operation. Co-ordinate installation with the hardware installer.
- .4 Generator Alarm Connections
 - .1 Provide wiring, conduit and connection to the generators for supervisory status and trouble signals.

3.2 TESTING AND CERTIFICATION

- .1 Arrange with the manufacturer to conduct a complete inspection and test of all installed fire alarm and voice communication equipment including all components such as manual stations, signaling devices, heat detectors, smoke detectors, speakers, fire fighters handsets, controls, etc. Test and verify connections to equipment of other Division such as sprinkler valves, elevators, etc. Co-ordinate with and arrange for staff of other divisions to be present where required.
- .2 Provide staff to test devices and all operational features of the system for witness by the Consultant and Authority having Jurisdiction. Provide 2-way radio communication at each annunciator, control point and other areas in the building as required. All testing must be witnessed by the Owner's representative prior to acceptance.
- .3 Test and verify the total system to ensure satisfactory operation in conformance with latest version of CAN/ULC-S536 and CAN/ULC-S537, "Standard for the Verification of Fire Alarm System Installations".
- .4 Carry out testing, verification and certification as follow:

- .1 System test in conjunction with the manufacturer.
- .2 Correction of all deficiencies.
- .3 Submission of test results to t h e Consultant for review including letter of certification from the manufacturer(s).
- .4 Witness of complete system by the Consultant and/or his representatives.
- .5 Correction of any deficiencies noted.
- .6 Acceptance of the system by the Consultant.
- .7 Witness of system test by the Authority Having Jurisdiction.
- .8 Correction of any deficiencies requested by the Authority Having Jurisdiction.
- .9 Submission of manuals with final verification sheets.
- .5 All costs involved in the testing and certification shall be included in the Contract Price.

3.3 TRAINING

- .1 Provide the services of a factory-authorized service representative to demonstrate the system and train the Owner's maintenance personnel as specified below.
 - .1 Train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 4 hours training.
 - .2 Schedule training with the Owner at least seven days in advance.

END OF SECTION

1.0 GENERAL

1.1 SUMMARY

- 1.1.1 This Section of the Specification is an integral part of the Contract Documents and shall be read accordingly.
- 1.1.2 Comply with General Conditions, Supplementary Conditions of the Contract, and Section 26 00 00 – Electrical General Requirements
- 1.1.3 Comply with section 26 10 00 – Basic Materials & Method.
- 1.1.4 Comply with EIA/TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
- 1.1.5 Comply with J-STD-607-A, Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.2 SCOPE

- 1.2.1 Provide empty raceway systems including conduits, terminal cabinets, plywood backboards, pull boxes, outlets and cover plates for enclosure of wiring.
- 1.2.2 Telecommunication systems include, but not limited to, voice, data, cable TV, P.A., security and access control, emergency alarm, CCTV, CATV, etc.
- 1.2.3 Co-ordinate with system contractors for all the work.
- 1.2.4 Provide P.A. speakers backboxes.

2.0 PRODUCTS

2.1 MATERIALS

- 2.1.1 Wall outlets shall be 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted in the Contract Documents. Provide stainless steel cover plates for the outlet boxes for future use.
- 2.1.2 Conduit size shall be in accordance with systems contractor's requirements and recommended standards.
- 2.1.3 Minimum pull box size shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:-
	Width	Length	Depth	
27mm	102mm	406mm	76mm	51mm
35mm	152mm	508mm	76mm	76mm
53mm	203mm	914mm	102mm	127mm
78mm	305mm	1219mm	127mm	152mm
103mm	381mm	1524mm	203mm	203mm

- 2.1.4 Plywood backboards shall be minimum 1200 mm x 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.
- 2.1.5 Provide a minimum of 2 duplex receptacles on separate circuits at each backboard.
- 2.1.6 Provide grounding at each backboard.

3.0 EXECUTION

3.1 INSTALLATION

- 3.1.1 Vertically mount outlet boxes, unless noted otherwise in the Contract Documents, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.

- 3.1.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8" nylon pull cord (minimum 400LB) continuously from outlet to outlet, through conduit and fasten at each box.
- 3.1.3 Conduit bonds shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.
- 3.1.4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30,000 mm in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease.
- 3.1.5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by systems contractors to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.
- 3.1.6 Co-ordinate with P.A. supplier for types and sizes of P.A. speakers backboxes to be provided as required by the electrical Subcontractor and proceed accordingly.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

- .1 The Security Access Control System must be a fully integrated solution consisting of access control, CCTV and intrusion detection. The Security Access Control System shall be based on Lenel OnGuard 7.4 with the latest models of Mercury hardware. The intrusion solution shall be based on Bosch D9412GV4 intrusion panel and B9xx series keypad. The integration of the access control and intrusion parts of the system shall be achieved via the network for full control of both components via the server as well as on a local level for seamless offline operation. A minimum integration of ARM/DISARM and General alarm shall be guaranteed in the offline mode between the systems.
- .2 The system must be configured to arm using a card swipe and a button press. The system must disarm on the perimeter access granted – door opened event. The system shall not arm until all intrusion points are fault free. All relevant information must be displayed on the Bosch keypad as well as OnGuard interactive map. Integration between access control hardware, OnGuard software and intrusion system must be seamless in both online and offline modes.
- .3 The Contractor shall work with the Region on the technical design of the system, clarification of technical requirements, and provide a full set of technical drawings for approval before proceeding to installation. Technical Shop Drawings shall include, but not be limited to high level riser diagram(s), system riser diagram(s), network diagram(s), termination/wiring diagram(s), device landing schedule(s), intrusion detection points schedule(s), tub/enclosure layout diagram(s), and explanation of the sequence of operation, integration techniques and operational scenarios.
- .4 The installation of all required conduit, cabling and device/panel installation and termination shall be done by a licensed electrical contractor (Installation Subcontractor). The Contractor shall employ the installation services of the Region's approved licensed electrical contractors (pre-qualified Lenel System Installers) listed in section 1.2 below. All necessary cable, conduit, fittings, and other general installation hardware shall be specified by the Contractor and supplied and installed by the Installation Subcontractor. The Contractor shall be fully responsible for the work completed by its Subcontractors, including the Installation Subcontractor, electrical, locksmith and door hardware Subcontractors.
- .5 The Contractor shall be responsible for supplying the system hardware in accordance with the Contract Documents, including Specifications and Drawings provided by the Region.
- .6 The Contractor shall be responsible for providing required on-site installation training for the Installation Subcontractor, if necessary, and supporting them during the installation.
- .7 Where an item is shown on the Drawings and is specified in this Specification Section, such item shall conform to the requirements of this Specification Section.
The Contractor shall provide design drawings identifying all physical security devices at each field location in accordance with the requirements provided by York Region
- .8 The Installation Subcontractor must be, as a minimum, CANASA (Canadian Alarm and Security Association) certified. Additional certifications include CFAA (Canadian Fire Alarm Association) certified, and NFPA (National Fire Protection Association) certified.

- .9 Related documents: Conform to CANASA Canadian Alarm and Security Association installation guidelines.
- .10 Submit to the Electrical Safety Authority (ESA) and any other applicable authority the necessary number of working drawings and specifications for examination and approval prior to commencement of work as required.
- .11 Carry out all changes and alterations required by the authorized inspector of the ESA and any authority having jurisdiction without delay to the progress of the Work and without extra cost.
- .12 The Contractor shall train the Region's personnel to fully operate and perform routine maintenance on the systems and equipment installed.
- .13 The Contractor shall provide all warranty services for facility security system for a period of two (2) years from the date of Total Performance of the Work, and shall provide all necessary material required to replace defective products during this period.

1.2 LENEL SECURITY SYSTEM VALUE ADDED RESELLERS (VAR)

- .1 Security Control System shall be provided by one of the VARs prequalified under Request for Pre-qualification No. PQ-18-50 listed below. The Contractor shall ensure that the VAR provides the services as detailed in this Section:

- .1.1 The following are the pre-qualified Lenel Security System Value Added Resellers:

360 Advanced Security Corporation
Dan Baynton
dan.b@360asc.com
416-798-2228

Convergent Technologies Ltd.
Healey Willan
healey.willan@convergent.com
647-390-5159

Chubb, UTC Fire and Security Canada Inc.
Stephen Yates
stephen.yates@chubbedwards.com
905-629-2600

- .2 Installation and integration of the Lenel security system(s) shall be completed by, one of the installers pre-qualified under Request for Pre-qualification No. PQ-18-222 listed below.

- .3 The following are the pre-qualified Lenel Security System Installers (alphabetical order)

Electro-Works Ltd.
Dondi Keough
Dondi@tcsecure.ca
416-529-7180

OZZ Electric Inc.
Mr. Adrian Masci Manager
amasci@ozzelectric.com
647-628-7304

Symtech Innovations Ltd.
Brent Stewart
Brent.Stewart@symtech.com
416-559-1094

1.3 REFERENCES

- .1 EEMAC TC3 PVC Fittings for use with Rigid PVC Conduit and Tubing.
- .2 CSA C22.2 No. 211.2-06 Rigid PVC (Unplasticized) Conduit.
- .3 CAN/CSA C22.2 No. 18-06, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.

.4 Surveillance System Related References:

1. Canadian ICES-003 (Interference Causing Equipment Standard Policy)
2. Canadian Standards Association (CSA)
3. Conformity for Europe (CE)
4. Consultative Committee for International Radio (CCIR)
5. Electronic Industry Association (EIA)
6. Electrical Testing Laboratories (ETL)
7. Federal Communications Commission (FCC)
8. Joint Photographic Experts Group (JPEG)
9. Moving Picture Experts Group (MPEG)
10. National Television Systems Committee (NTSC)
11. Phase Alternating by Line (PAL)
12. Underwriters Laboratories Inc. (UL)

1.4 SOFTWARE/SYSTEM CONFIGURATION.

- .1 The Security Access Control System installed as part of this Contract shall be added to the existing Lenel OnGuard system. All programming and configuration for the work under this Contract must be consistent with the existing programming to guarantee consistent functionality of the system and all of its components across the Region.
- .2 The Contractor is only responsible for the work related to this Contract and shall NOT adjust or alter the existing configuration for any other facilities within the system without a written authorization from the Region. The Contractor shall NOT alter, modify, delete or interfere in any way with any settings, configuration or variables that may affect the functionality of the existing facilities, systems or their components without prior written authorization from the Region.
- .3 The installed Security Access Control system must be configured to meet all existing Regional standards (Security, Operational, IT). The Contractor shall be responsible for collecting the requirements, developing a custom solution to meet the requirements, and presenting available options in a form of an implementation plan to the Region for approval before implementing the solution.
- .4 All software licensing must be detailed, supplied and installed to operate the security solution. The Contractor shall supply and install the necessary Lenel Bosch integration licenses, card reader licenses and workstation license. It is the Contractor's responsibility to quantify and provide the number of licenses required based on the Drawings and Specifications provided in the Contract Documents. All costs associated with provision of the required licenses shall be included in the Contract Price.
- .5 The Contractor shall work with the Region's IT department to perform application or database server programming and/or configuration. All work requiring access to the database and/or application servers must be coordinated with the Region a minimum of one week in advance.
- .6 All server, network, and other requirements shall be coordinated with the Regional IT Services department and validated by the manufacturer prior to installation. All servers and network switches shall be provided by the Region unless specified otherwise in the Contract Documents.
- .6 The software and/or system deployment and configuration shall be overseen and validated by the Regional representative(s).

- .7 The Contractor shall create graphical map interface for the system, making it same or similar in appearance and functionality to the existing graphical maps. The graphical map interface shall be multilayer hierarchy with the main map represented as a map of York Region with municipality boundaries. The Regional facilities shall be represented by different icons depicting corporate, environmental, transportation, paramedic and other departments. Each facility shall be represented by the architectural floor plan, uploaded from the Region provided AutoCAD drawing, multilayered, if necessary, for areas, floors, buildings. The graphical interface shall represent all field devices and their associated status types, including but not limited to armed, disarmed, normal, forced, held open, locked, unlocked, tamper, on schedule, offline, etc. The Contractor shall use the existing custom dynamic icons to populate the graphical interface or create new if necessary.

1.5 SUBMITTALS

- .1 The Contractor shall submit prior to the start of construction all relevant technical documentation, complete set of technical drawings and specifications.
- .2 The Contractor is required to present adequate documentation covering the entire scope and extent of the completed work prior to Substantial Performance of Work, including but not limited to:
- a) Theory of Operation – system outline and overview
 - b) System Configuration and Administration - Description of details required to prepare the System for implementation, including system planning, layout, functionality and configuration options
 - c) Operation - Submission of operational manuals explaining the system operator's available features, functions, and capabilities
 - d) Administration - Submission of system administration manuals including operational and maintenance requirements and procedures associated with the proposed solution. Description of administrative functions required to supervise and manage the integrated System
 - e) Product Manuals – Submission of complete manufacturer's manuals for all System software and hardware components. Specifications, by make and model, for all devices used must be submitted. The Contractor shall provide a full set of maintenance manuals and operating instructions in electronic format on a USB portable hard drive. This shall include comprehensive descriptive data sheets, brochures, installation, and technical manuals for all systems and equipment forming part of the contract. The manuals shall include operational and schematic diagrams for the System and all related components
 - f) The Contractor shall submit a full schedule of maintenance to be carried out on each system component during the warranty period of 24 months after the date of Total Performance of the Work and for entire lifetime of the system and its components
 - g) As-built drawings – the Contractor shall provide a digital copy and one full hardcopy set of accurate As-built drawings depicting the entire scope of work, including but not limited to network connectivity diagrams, high level riser diagram(s), system riser diagram(s), vertical and horizontal wiring diagrams,

termination/wiring schematic(s), device landing schedule(s), intrusion detection points schedule(s), tub/enclosure layout diagram(s), explanation of the sequence of operation, integration techniques and operational scenarios, addressing charts and other relevant information, product specifications, and cut-sheets, as-built floor plans and detailed commissioning documentation. In addition all technical notes, scripts and other documentation covering the IT portion of the Work specified in the Contract Documents.

1.6 TESTING AND QUALITY ASSURANCE

- .1 The Contractor shall ensure all hardware and software components are functioning as intended within the Region's IT and network environment.
- .2 At the discretion of the Region, final acceptance testing shall be carried out at the following defined levels: per point basis; per system component basis; per software function basis; and per total system basis.
- .3 The Contractor shall test and verify the proper installation and functionality of the system and all of its components including integration to the systems described in this Section, application and database integration as well as online and offline operation to the satisfaction of the Region.
- .4 The Contractor shall inspect all installed devices and equipment for visible damage or tampering which may interfere with the intended system functionality.
- .5 The Contractor shall test all field devices and system components that are configurable or adjustable to ensure proper settings and intended functionality at the location of installation. All configurable settings must be approved by the Region prior to installation. The Contractor shall operate all field devices to verify proper functionality.
- .6 For all failed tests the Contractor shall make all necessary repairs and perform retests. Failure of the test may require the retest of one or more individual tests. Repairs and retests shall be by the Contractor until all tests are passed to the Region's satisfaction without extra cost to the Region.

1.7 TRAINING

- .1 Adequate training shall be provided to the Regional staff including but not limited to system operators, administrators and support staff. A minimum of 4 hours of system training shall be provided to the Regional staff.
- .2 System instruction shall include complete information regarding system operations, management and maintenance. Training sessions must be clearly identified and broken down into significant topics.
- .3 Training documentation shall be developed by the Contractor in adequate quantities to satisfy requirements of the training; and submitted by the Contractor for future reference by the client in printed and electronic formats.
- .4 The Contractor shall also assist the Region in configuring, and/or reconfiguring, and populating, and/or repopulating all System related databases, integrations, configuring and/or reconfiguring all the system parameters to the Region's satisfaction. The Contractor's assistance shall continue until initial configurations and integrations are complete and functional, and/or until all system parameters are working to the Region's

satisfaction. Assistance shall be one technician working side by side with the Region's representative(s) assisting and instructing the Region's representative(s) step by step in configuring system parameters and integration configurations to the systems outlined in the Contract Documents.

- .5 Training shall cover all aspects of all the systems and subsystems under the Scope of the Work included in the Contract Documents.

1.8 NETWORK TCP/IP COORDINATION

- .1 The Region's Project Manager will coordinate for the installation of a network system component with ITS (Information Technology Services) Department and the appropriate BSA (Business System Analyst) at the Site to allow for communications to the database server(s) at Region's Central Monitoring Station to perform final tie in and commissioning.
- .2 If local IT Network infrastructure is not present, Wireless 3G/LTE network equipment shall be used. York Region ITS will supply the pre-configured Wireless Modem and network switch as well as installation specifics.
- .3 The Contractor shall install all required conduits and junction boxes as well as the exterior antenna for the Wireless equipment, in a location determined by ITS to achieve adequate network connectivity.
Network switch is to be located within the Lenel security system cabinet. Both modem and switch shall be powered from Lenel UPS power supplies.

1.9 SHOP DRAWINGS

- .1 Submit shop drawings showing the proposed location of all equipment to be installed under this Contract.
- .2 Shop drawings submission shall include:
 - .1 Schematic
 - .2 Wiring
 - .3 Interconnection Diagrams
- .3 Additional Requirements:
 - .1 For devices containing dip switches, jumpers or programming keypads include:
 - .1 Functional description.
 - .2 Performance data.
 - .3 Physical, electrical and environmental requirements.
 - .4 Location drawing.
 - .5 Equipment descriptive literature.
 - .6 Wiring details.
 - .2 For programmable equipment, communication links and networks, submit bill of materials. Include in bill of materials hardware documentation.
 - .1 For hardware items include and clearly identify: Description, make, model, part number and serial number.
 - .2 For documentation include: Title and publisher for each item.
 - .3 For Programmable Equipment Hardware include:
 - .1 Product description for each item including:

- .1 Wiring and installation instructions.
 - .2 Functional description.
 - .3 Performance data.
 - .4 Physical, electrical and environmental requirements.
 - .5 Adapters and controllers.
 - .2 Equipment layout drawings showing location of hardware, boards, jacks, cables and terminals.
 - .3 Related field tag numbers and wire numbers, module tag assignment, rack module assignment, terminal and terminal strip numbers.
 - .4 Location and identifier and pin assignment of plugs, jacks, and cables.
 - .5 Switch settings and addresses, firmware.
 - .6 Interconnection Diagrams including wiring, cables, jacks between internal and external components, power supplies, processors, communications modules, racks, input/output modules and peripherals. Label terminals, jacks and pins. Show settings for jumpers and switches. Show address for each hardware module and point.
- .4 Review of shop drawings shall be in reference to general design only. Review of the shop drawings shall not in any way relieve the Contractor of responsibility for errors or interference, or from the necessity of furnishing such works and materials as may be required for the completion of the work at any time until formal acceptance.

2 PRODUCTS

2.1 CONTROL PANEL

- .1 Lenel Intelligent System Controllers (To be specified by the Contractor during the design of the security system).
 - LNL-2220 Intelligent Dual Reader Controller (IDRC) provides a single board solution for interfacing one or two doors to an OnGuard® system. On-board Ethernet 10/100Base-T port, 6 MB on-board, non-volatile flash memory, Battery-backed, non-volatile storage of 50,000 events, 16 different formats, 12 or 24 VDC input power, 32 downstream devices.
 - The LNL-3300 Intelligent System Controller (ISC) by Lenel is designed for advanced access control applications. On-board Ethernet 10/100Base-T port, 15 MB on-board, non-volatile flash memory, Battery-backed, non-volatile storage of 50,000 events, 16 different formats, 12 or 24 VDC input power, 64 downstream devices via two individual downstream RS-485 ports.
 - The LNL-4420 is an Advanced Dual Reader Controller by Lenel that provides a single-board solution for interfacing up to 64 doors, plus auxiliary inputs and outputs, to an OnGuard® system.
- .2 Bosch D9412GV4 Control Panel Alarm Panel for intrusion devices: Burg, Commercial Panel 246 individually identified points, 32 areas. ULC listed. To be used in combination with Bosch B426 Conettix Ethernet Communication Module.
- .4 Back up UPS Pro to power all security, access control and wireless network solution. Model to be used is Antigen-presenting cell ("APC") Pro BR 1500G or equivalent. The UPS must reside on an isolated and dedicated AC circuit fed from emergency power panel wherever available.

2.2 **KEYPAD**

- .1 Bosch B942 Touch Screen Keypad for office corporate sites.

Input/Output module

- .1 LNL-1100: Series 3 Lenel® Input Control Module (ICM) provides the access control system with high-speed acknowledgement of critical alarm points in monitored areas. 16 configurable input control points, 2 output control relays, supports normally open, normally closed, supervised and non-supervised circuits, Grade B, A, and AA line supervision, 12 or 24 VDC input power, Elevator control, support for 128 floors, Advanced Encryption Standard (AES) 128-bit or 256-bit encryption.
- .2 LNL-1200 Series 3: Lenel® Output Control Module (OCM). 16 Form-C 5 A, 30 VDC contacts for load switching, 2 dedicated digital inputs for tamper and power failure status, Elevator control, support for 128 floors, Advanced Encryption Standard (AES) 128-bit or 256-bit encryption.
- .3 Bosch B208 SDI2 8-Input Expansion Module
- .4 Bosch B308 SDI2 8-Output Expansion Module

2.3 **WEIGAND INTERFACE UNIT**

- .1 LNL-1300 Series 3: Single Reader Interface (SRI) Module. Access control card readers, keypads, or readers with keypads that use standard Wiegand Data1/Data0, Supervised or Unsupervised F2F, or Clock/Data communication are supported, as are those supporting the bidirectional RS-485 Open Supervised Device Protocol (OSDP™). 12 or 24 VDC power supply, Two Form-C relay outputs (5 A door strike and 1 A aux relays), Up to 16 different card formats, Door contact and REX open or closed, supervised or non-supervised, Strike control output
- .2 LNL-1320 Series 3: Dual Reader Interface (DRI) Module: Access control card readers, keypads, or readers with keypads that use standard Wiegand Data1/Data0, Supervised or Unsupervised F2F, or Clock/Data communication are supported, as are those supporting the bidirectional RS-485 Open Supervised Device Protocol (OSDP™). 12 or 24 VDC power supply, Six Form-C 5 A at 28 VDC relay outputs, Up to 16 different formats, Door contact and REX open or closed, supervised or non-supervised, Strike control output, Dedicated tamper and power failure circuits, On-board regulator allows 12 VDC reader support from 24 VDC power source
- .3 LNL-8000: The Star Multiplexer from Lenel is designed to implement star topology on a downstream port of any Lenel® Intelligent System Controller or on any host communication port of any OnGuard® server. Up to eight RS-485 (2-wire) connections or four RS-485 (4-wire) connections can be made downstream of the LNL-8000. Host communications - 38.4 Kbps direct wire (RS-232/RS-485 multi-dropped), 12 VDC input power, Status LEDs for heartbeat, upstream and downstream communication.

2.4 MULTITECHNOLOGY ICLASS READER

- .1 Card Readers: Provide multi-technology iClass / proximity card readers where shown on the Drawings and/or where required by the Contract. Card Readers shall be rated for indoor and outdoor use, have multicolour LED with beeper for operator status indications and will operate on 5-16 VDC. Provide thin line mullion style readers where required to match door frame configuration.
- .2 HID Corporation, Multi-technology card reader RP15/RP40/RPK40.

2.5 PROXIMITY CARD

- .1 Proximity Cards used by the Region are HID Corporation ProxCard II, HU-1326LSSSV
- .2 The Contractor is not required to supply proximity cards to the Region

2.6 DOOR CONTACTS

- .1 Magnetic door contacts.
- .2 GE Security/Interlogix 1078, or equivalent
- .3 Interlogix SR-2207ADL Overhead door contact or equivalent. Overhead door contact to be installed off the ground. Alternative solution might be required based on door type, mounting requirements, and environment.
- .4 Sentrol 2800T Series Magnetic explosion proof door contacts to be used in Class 1, Div.1 and Div.2 classified areas.
- .5 Honeywell LSX Series mechanical explosion proof overhead door contacts to be used in Class 1, Div.1 and Div.2 classified areas.

2.7 BATTERIES

- .1 Gel Cell back-up batteries, 12V, 7 amp-hours.
- .2 Exaltor, UltraTech or equivalent.

2.8 EXIT DEVICE/PANIC BARS

- .1 Push pad exit device, dull chrome finish, UL Listed Panic Hardware FVSR SA163 (N), tested in accordance to ANSI A156.3, 1989, Grade 1.
- .2 Von Duprin 99K-NL Series Exit Devices, or equivalent.

2.9 ELECTRIC DOOR STRIKES

- .1 Heavy duty, stainless steel construction, 3000 lbs. Static strength, UL 1034, ANSI/BHMA Grade 1, .25 Amps @ 24VDC.
- .2 Hess Inc. Series Strikes 1006, or equivalent.

2.10 **ELECTRICAL POWER TRANSFER**

- .1 Transfer of electrical power from door frame to the edge of a swinging door; two (2) 18 AWG wiring, 24VDC, 2A, 16A maximum surge.
- .2 Von Duprin Inc. EPT-2, or equivalent.

2.11 **TRANSFORMERS**

- .1 120V input, 16V output, 40VA, 60 Hz, single phase rating, copper conductors, dry type
- .2 Transformers shall be designed, constructed and rated in accordance with UL, CSA and NEMA standards.
- .3 All transformers to be from the same manufacturer.
- .4 ATC Frost Magnetic Inc., 1640, or equivalent.

2.12 **REQUEST TO EXIT SENSORS**

- .1 Wall mount high impact ABS plastic enclosure, alarm output: form "C" contact, single or double door use, adjustable to 60s, UL Listed.
- .2 Honeywell IS310, or equivalent.

2.13 **PUSH BUTTONS**

- EXIT PUSH BUTTON
- .1 Wall mount brushed stainless steel plate enclosure, momentary switch output, SPDT 10A @ 125/250 VAC, UL Listed.
- .2 Tyco Security Products - Kantech PB-EXIT, or equivalent.
- ARMING PUSH BUTTON
- .3 RCI R991RBPTD9 Wall mount brushed stainless steel plate enclosure, push button with pneumatic time delay, blank red button.

2.14 **MOTION DETECTORS**

- .1 Wall mount motion monitor with temperature compensation, high impact ABS plastic enclosure, alarm output: form "C" contact, 125mA @ 28 VDC, tamper and trouble output contacts, UL Listed.
- .2 Detection Systems DS940Q, Optex DX40 or equivalent.

2.15 **AUDIO ANNUNCIATOR**

- .1 Wall mount, 24VDC, 100dB @ 10', UL Listed.
- .2 Toxalert Inc. HORN/REM, or equivalent.

2.16 **DIGITAL VIDEO MANAGEMENT SYSTEM (DVMS)**

- .1 Lenel Milestone XProtect® Expert Digital Video Management System. The Digital Video Management System (DVMS) shall be designed and developed to the following standards:

- ISO 9001 (2000)
- ISO/IEC 15504 Level 3 or higher
(SPICE 2.0 Software Process Improvement and Capability Determination)
- SEI CMM Level 3 or higher
(American Software Engineering Institute - Capability Maturity Model)

The Digital Video Management System shall include:

- Database Server(s)
- Application Server(s)
- Local recording Networked Camera Server(s) with appropriate software and databases as required
- Operator Workstations
- Network connected cameras and/or network connected video encoders
- Continuous Recording capability for a minimum thirty (30) days at 30 frames per second (note: see more on the attached camera configuration parameters)

- .2 The Digital Video Management System ("DVMS") shall be capable to support unlimited number of cameras.

As a minimum, the system must support all latest Axis network cameras, encoders and camera streamers.

- .3 The following DVMS equipment must be used:

- Camera Streamers / Video Encoders:
 - AXIS Communications
- PTZ Network Cameras:
 - AXIS Communications Q6055-E
- Fixed Indoor Dome Cameras:
 - AXIS Communications P3375-LV
- Fixed Outdoor Dome Cameras:
 - AXIS Communications P3375-LVE
- Fixed 360 Indoor/Outdoor Camera:
 - AXIS Communications P3707-PE

Use the latest generation of the abovementioned equipment.

The DVMS shall support at least industry-standard Motion JPEG, MPEG-4, H.264, and H.265 as well as Axis's Zipstream technology encoding formats.

- .3 The DVMS system shall be fully integrated with the Lenel OnGuard 7.4 or higher. Lenel OnGuard shall be used as the primary user interface.

.4 Network and Video Cabling

A Local Area Network (LAN) shall be provided for communication between the system elements. All interfaces to the LAN shall be a minimum of 1000BaseTX Ethernet. The LAN may use additional technologies within the backbone for greater speed or distance.

Acceptable types are:

- o FDDI (Fiber Distribution Data Interface)
- o 1000BaseSX or 1000BaseLX Gigabit Ethernet
- o Asynchronous Transfer Mode (ATM)
- o 1000BASE-TX

The LAN shall use standard network cables. Acceptable cable types are:

- o Optical Fiber
- o Category 6 or greater Unshielded Twisted Pair (UTP)

The LAN shall be logically and/or physically separate from any existing LAN infrastructure. Interconnection to other LANs shall be through one of the following:

- o A router
- o A Layer 3 capable network switch
- o As an additional VLAN to the existing LAN equipment. Where required to interconnect VLANs, a router or Layer 3 capable switch shall be provided

.5 It is not acceptable for network video cables to be run back to the Camera Server. All communications with the Camera Server shall be via the LAN. Each network camera or video streamer shall have a single network interface to be used for video and Pan/Tilt/Zoom communications.

.6 Supply a complete and working Closed-Circuit Television System (CCTV) System and Digital Video Management System (DVMS).

2.17 **CONDUIT, FASTENINGS AND FITTINGS**

.1 Comply with OESC

.2 Rigid PVC conduit: Conduit, including elbows and fitting, Schedule 40 wall thickness, solvent weld connections, by IPEX Inc., Carlon or equivalent.

.3 Conduit straps for rigid steel and PVC conduit: Malleable iron, hot-dip galvanized, single hole type for conduits up to 50 mm, two-hole type for conduits larger than 50 mm.

.4 Beam clamps: Hot dip galvanized steel designed to clamp onto both sides of the flange. Cat. #S997BC-HG (100-230 mm flange) by Sasco Tube & Roll Forming Inc., Cat. #S999BC-HA (175-430 mm flange) by Sasco Tube & Roll Forming Inc., or type CS91 by Construt Inc. or equivalent.

.5 Rigid PVC conduit connectors: Adapter type with threaded male portion, by IPEX Inc., Carlon or equivalent.

.6 Expansion couplings: With ground straps or clamps. Type XJ by Cooper Crouse-Hinds Canada or equivalent.

.7 Swivel couplings: Threaded, one piece, by Elliot Electrical Manufacturing Co. Running threads are not acceptable or equivalent.

- .8 Conduit spacers: Malleable iron, sized to suite conduit size, by O-Z/Gedney Co., or 1300 Series by Thomas & Betts Ltd or equivalent.
- .9 Pull cords: 6 mm polypropylene or nylon material. Pro-pull rope by Ideal. Industries Inc.
- .10 Bituminous backpaint: In accordance with CAN/CGSB-1.108.

2.18 **WIRING AND MISCELLANEOUS**

- .1 Provide all RS-232, RS-485, Optical Fibre and Ethernet cabling, and Fibre and Ethernet jacks as required for a complete network, if applicable. Direct burial cable for all outdoor applications.
- .2 RS-485 Cables
 - .1 EIA Industrial RS-485.
 - .2 Conductors: Twisted pair, each conductor No. 22 AWG stranded copper.
 - .1 Pairs: 2.
 - .2 Shield: Aluminum-polyester and 90% copper tinned braid.
 - .3 Jacket: Black UV resistant PVC.
 - .4 Electrical Characteristics at 20°C
 - .1 Capacitance: 36.1 pF/m
 - .2 Impedance: 120 ohms
 - .3 Propagation Velocity: 78%
 - .5 Belden Datalene Insulated 3107A.
- .3 Lenel hardware wiring shall follow the below wiring guide:

Purpose	Cable type	Gauge	Cond.	Description	Belden number
RS-485, 4-wire	Non-plenum	24	2P	Overall shield	9842
RS-485, 4-wire	Plenum	24	2P	Overall shield	88102
RS-232	Non-plenum	24	5	Overall shield	9610
	Plenum	24	6	Overall shield	83506
Reader drops	Non-plenum	24	2P	Overall shield	9502
	Non-plenum	22/24	6	Overall shield	5504FE, 9536
	Plenum	22/24	6	Overall shield	6504FE
12 VDC power	Non-plenum	18	2	Overall shield	5300FE, 8760
	Plenum	18	2	Overall shield	6300FE, 88760

.4 CAT6A Cables

- .1 Conform with the following plenum rated Ethernet 1000BASE-TX TIA/EIA 568-B.2-1 Category 6 cable:
 - .1 CSA Certified for trays and risers.
 - .2 Conductors: Unshielded twisted pair, #23 AWG solid copper.
 - .3 Pairs: 4
 - .4 Jacket: Purple Flamearrest, CSA FT4/FT6 rating.
 - .5 Certification/Testing to Category 6 in accordance with the current TIA/ISO Channel Standards.
 - .6 Belden Inc. #2400 or equivalent.

.4 Instrumentation Cables (4-20mA)

- .1 Belden Inc. #8760 or equivalent.
 - .1 #18 AWG.
 - .2 16-stranded copper.
 - .3 Beldfoil aluminium polyester shield.
 - .4 Twisted shielded pair.
 - .5 Bare #20AWG copper drain wire.

.7 Wiring Accessories

- .1 Wire and cable markers: Printable, self-laminating, self-adhesive markers, white background, black lettering on white background, vinyl plastic or polyester film suitable to environment. Wire marker to be sleeved with clear heatshrink tubing.
- .2 Terminal blocks: 600 V, 25 A minimum rating, modular, 35 mm DIN rail mounted, provision for circuit number labelling, individually removable, sized to accommodate conductor size and circuit current. Sak Series by Weidmuller Ltd., UK Series by Phoenix Terminal Blocks Ltd., WK Series by Wieland Electric Inc., ABB Entrelec or equivalent.
- .3 Field wiring terminations: Where screw-type terminal blocks are provided, supply insulated fork tongue terminals. Sta-Kon by Thomas & Betts Ltd., Scotchlok by 3M Canada Inc or equivalent.
- .4 Moisture and waterproofing: In wet locations, with Liquid Tape by Ideal Industries Canada Corp. or equivalent.
- .5 Cables ties: Nylon, one-piece, self-locking type, by Thomas & Betts Ltd., Burndy Inc., Wieland Electric Inc or equivalent or equivalent.
- .6 Electrical insulating tape: Scotch 33 by 3M Canada Inc or equivalent.
- .7 Cable grips: To accommodate type and geometry of cable supported, single weave, variable mesh design, by Thomas and Betts Ltd., Crouse Hinds, Woodhead Canada Ltd or equivalent.

- .8 Cable pulling lubricant: Compatible with cable covering and not to cause damage or corrosion to conduits or ducts. Yellow or clear 77 by Ideal Industries Canada Corp. or equivalent.
- .9 Input 120VAC power to all security related access control panels must be provided at each location identified in the design drawings and must be dedicated and isolated from any other loads.

2.19 **LOCKSMITHING AND DOOR HARDWARE**

- .1 All doors to be equipped as outlined in the associated Security Device Summary document. Where specifics are not available, doors should be equipped with Sergeant, Assa Abloy or Corbin locksets, compatible with future replacement of the cylinder core with a Medeco M3 IC core cylinder.
- .2 Interior exiting through any door (not overhead doors) should involve the use of a push paddle exit device installed at a standard height.

3 EXECUTION

3.1 **INSTALLATION – CONDUITS**

- .1 Connect conduits to electrical boxes and electrical equipment enclosures in wet or sprinkle system equipped areas with watertight conduit connectors.
- .2 Install conduits to conserve headroom in exposed locations and to minimize interference in spaces through which they pass.
- .3 Install conduits 150 mm minimum clear of steam and hot water pipes and 1000 mm minimum clear of heaters.
- .4 Provide rigid galvanized steel conduits, minimum trade size 19 mm for concealed or exposed conduits and 25 mm for conduits embedded in concrete.
- .5 Provide rigid PVC conduit underground or in corrosive areas. Provide 50 mm thick concrete tiles to protect direct buried PVC conduit. Direct burial cable type to be used in all underground applications.
- .6 For conduit systems in or running through hazardous areas, provide conduit, fittings, seals and associated components complying with OESC.
- .7 Install exposed conduits symmetrical with building construction and with accepted bends or pull boxes where conduits change direction.
- .8 Provide expansion fittings in straight conduit runs exceeding 60 m and at building expansion joints.
- .9 Install conduits and fittings surface mounted.
- .10 Install conduits recessed in brick or bare concrete block walls as walls are being erected. Do not cut into walls after walls are in place. Do not install horizontal runs in masonry walls. Do not install conduits in terrazzo or concrete toppings.

- .11 Attach exposed conduits in place with galvanized steel hangers one-hole straps spaced at 1300 mm centres maximum. Group conduits together whenever possible. Use galvanized steel hangers and supports. Perforated straps are not acceptable.
- .12 Provide pipe spacers for exposed conduits on concrete or masonry walls.
- .13 Provide drill-in type expansion bolts and machine screws for supporting hangers and straps.
- .14 Locate conduits penetrating floors, permitting direct vertical connection with minimal bending.
- .15 Provide flexible liquid-tight conduit between rigid conduit system and equipment which may be subject to vibration or adjustment, such as motors or motorized equipment.
- .16 Provide flexible metal conduit between junction boxes and luminaries in office areas and outlets within office partitions.
- .17 For building interior concrete wall and floor penetrations excluding penetrations into wet wells or hazardous chambers, install Schedule 40 galvanized steel pipe conduit sleeves, protruding 50 mm through floors and flush with wall surfaces prior to pouring concrete. Size sleeve for free passage of conduit. Seal all penetrations for fire separation in accordance with the OBC.
- .18 Size conduits according to Inspection Authority (ESA) requirements.
- .19 Route conduits to avoid beams, columns and other obstructions.
- .20 To prevent corrosion of concrete embedded conduits, prior to concrete placement, apply 40 microns minimum of bituminous backpaint to conduit exterior surface at concrete entry points (150 mm inside and 100 mm outside the concrete).
- .21 Embedded conduits: Ensure that the maximum outside diameter of concrete embedded conduit is 1/3 of the structural slab thickness measured at thinnest point. Ensure minimum space between each conduit running parallel is 3 times the O.D. of largest conduit. Do not run conduits running parallel to beam axes, directly above beams. Offset conduits running parallel to beams by a minimum of 300 mm minimum from face of beam to outside wall of conduit. Cross conduits at right angles wherever possible. Run conduits in space between layers of reinforcing steel without deforming reinforcing steel pattern.
- .22 Cut PVC jacket conduit thread removing plastic jacket. Coat exposed metal with zinc rich primer. Tighten conduit utilizing strap wrenches. Coat damaged conduit surfaces and exposed threads as recommended by conduit manufacturer.
- .23 Coat damaged surfaces and exposed threads of corrosion resistant conduit as recommended by conduit manufacturer.
- .24 Ream cut conduits to remove burrs; paint completed galvanized steel joints and field cut threads with zinc rich primer paint.
- .25 Clean conduit run with an accepted cleaner equipped with a mandrel.

- .26 Provide watertight, steel capped bushings on ends.
- .27 Install expansion fittings on dry side of plastic water stops where required.
- .28 Where conduits pass through a waterproof membrane, provide an oversized sleeve before membrane is installed. Use cold mastic between sleeves and conduits.
- .29 Do not commence surface conduit installation Work until masonry ceiling, wall and floor finishes are completed. Finish surface mounted conduit installation Work prior to painting.
- .30 Touch up and repair coated conduits and fittings including any exposed threads with compound material supplied by conduit manufacturer.
- .31 For flush mounted panelboards, provide two 25 mm empty conduits (minimum) up to ceiling space and where applicable, two 25 mm empty conduits (minimum) down through floor into ceiling or basement space below.
- .32 Provide pull cords in conduits with 1000 mm of slack at each end.

3.2 INSTALLATION – WIRES AND CABLES

- .1 Provide wires of number and size (including corresponding raceways) required, with space conductors as indicated in the Drawings. Provide adequate wiring for actual equipment installed.
- .2 Provide wire and cable according to the drawings and security system requirements.
- .3 Pull cable into ducts, conduits and cable trays in accordance with cable manufacturer's recommendations. Use patented cable grips suitable for cable type, or pulling eyes fastened directly onto cable conductors.
- .4 Limit pulling tension and minimum bending radii to those recommended by manufacturer.
- .5 Prevent damage to cable jackets by utilizing adequate lubricant when pulling cables through ducts and conduits.
- .6 Support cables in manholes and utility tunnels on cable trays or cable racks.
- .7 Arrange cables in parallel rows on cable trays. Maintain cable spacing by fastening cables, with Velcro, a minimum of every 2000 mm minimum on straight horizontal runs and to each rung at bends, including two rungs of adjoining straight sections. Fasten cables on vertical tray runs every 1000 mm.
- .8 Connect cables to electrical boxes and equipment enclosures located in outdoor, wet or sprinkled areas with watertight cable connectors.
- .9 Provide cable grips for vertical and catenary cable suspension installations to reduce cable tension at connectors and at cable bends.
- .10 Install through wiring in junctions and pull boxes having no connection within the box. Leave a minimum of 150 mm of slack inside box.

- .11 Facilitate making of joints and connections by leaving sufficient slack in each conductor at panelboards, outlet boxes and other devices.
- .12 Do not connect more than three lighting circuits for three phase panels and two lighting circuits for single phase panels to a common neutral.
- .13 Use #10 AWG minimum for home runs to lighting panels exceeding 25 m.
- .14 Install instrumentation/system signal wires in separate raceways from power and control wiring.
- .15 Provide mechanical protection for cables within 1500 mm of the floor in buildings and within 2000 mm above grade outdoors.
- .16 Identify each cable by attaching a cable marker at each end, in all intermediate manholes, junction boxes and pull boxes.
- .17 Provide cable grips on vertical and horizontal cable suspensions.
- .18 Install cables to conserve headroom in exposed locations and to minimize the amount of interference in spaces through which they pass.
- .19 Do not install horizontal runs in hollow masonry walls.
- .20 Passage through any structural member or precast slab must be approved by the Consultant.
- .21 Where exposed, install raceways and cables parallel with building lines and group neatly.
- .22 Maintain the integrity of all fire separations by sealing around all cables where they pass through any fire barriers. Generally this includes all floors ceilings and concrete and masonry walls.
- .23 As far as is practicable, all feeder wiring shall be continuous from origin to panel termination without running splices in intermediate pull boxes or splicing chambers. Sufficient slack shall be left at the termination point to make proper connections to the equipment.
- .24 Do not embed armoured cables in concrete.

3.3 INSTALLATION – LENEL ONGUARD SYSTEM AND SECURITY DEVICES

- .1 Supply, install, test, and commission Lenel OnGuard system components, communication equipment, and associated equipment to ensure the functionality of complete security system and network. Report all construction defects which will affect the progress of the Work to the Region and the Consultant.
- .2 The Drawings have been developed on a conceptual basis. The Contractor is responsible for providing/verifying the quantities and part numbers contained in the following table, and for all additional components, cables, etc. required to complete the Work as defined in the Specifications and on the Drawings. Break down the Bill of Materials by room number.. The following table lists typical parts for the security system design. This list is to be used as a reference only. The detailed design to be done by the Contractor shall verify part numbers and quantities required.

Part#	Description
Access Control	
LNL-2220	Intelligent Dual Reader Controller
LNL-3300	Intelligent System Controller
LNL-4420	Advanced Dual Reader Controller
LNL-1300	Single Reader Interface Module
LNL-1320	Dual Reader Interface Module
LNL-1100	Input Control Module
LNL-1200	Output Control Module
RP15/RP40/RPK40	HID Corporation, Multi technology card reader to suit application
1078 or equivalent	Magnetic Door Contact
SR-2207ADL	Overhead Door Contact
LSXA3K1	Explosion Proof Mechanical Door Contact /w accessories to suit application
2800T	Sentrol 2800T Series Magnetic explosion proof door contacts
CK-IS310	REX Motion
2966906 PHOENIX	SPST Relay 12VDC with base or equivalent railmount
2912497 PHOENIX	SPDT Relay 12VDC with base or equivalent railmount
IM-1270	12V/7AH Backup Battery
LSP MCLASS	Life Safety Power MCLASS FlexPower Power Supply with backplate, no wire management. Enclosure by Hoffman
Hoffman NEMA 2 Enclosure	Hoffman enclosure to suit application and to fit corresponding LiSP backplate
Hoffman NAME 3 Enclosure	Hoffman enclosure to suit application and to fit corresponding LiSP backplate
Hoffman Nema 4 Enclosure	Hoffman enclosure to suit application and to fit corresponding LiSP backplate
R991RBPTD9	Arming Button, w/delay RED Blank
Hes 1006 KD	Hes 1006 KD 630 Electric Strike (provided by Locksmith)
Hes 9600	ES 9600 The surface mounted, windstorm rated solution for rim exit devices (Provided by Locksmith)
Intrusion	
D9412GV4	Bosch D9412GV4 Control Panel Alarm Panel
B208 SDI2	Bosch B208 SDI2 8-Input Expansion Module
B308 SDI2	Bosch B308 SDI2 8-Output Expansion Module
B942	Bosch B942 Touch Screen Keypad
B930 ATM	Bosch B930 ATM Style-Alpha Numeric Keypad (SD12)
B56	B56 Keypad Surface Mount Box
B426	Bosch B426 Conettix Ethernet Communication Module
FG-1625F or equivalent	Glass Break Detector
DS940Q, Optex DX40 or equivalent	Motion Detector

- .3 A minimum of 20% of alarm inputs and 20% of relay outputs to remain as spare. Unless otherwise noted in the Contract Drawings the Lenel security system inputs and outputs shall be 80% full, leaving 20% spare capacity.
- .4 The Lenel Controllers and Bosch hardware and additional nodes, if required during the detailed design, to be housed in NEMA 2, NEMA 3, or NEMA 4 rated Hoffman Enclosures or equivalent to suit application. Enclosures to be wall mounted and located as shown on the drawings. Equipment location and other mounting locations may be re-located with prior approval from the Region.
- .5 Life Safety Power MCLASS FlexPower Power Supply with backplate and power distribution modules to be used for the system design. Hoffman Enclosures or equivalent to be used to suit application. Enclosure and Power Supply solution to be presented to the Region for approval.
- .6 All Control Panels, where applicable, to be equipped with battery backup supply. Control Panel batteries to consist of 12V, 7AH.
- .7 Lenel and Bosch Security Systems and all other equipment to be installed according to the manufacturer's recommendations.
- .8 The Security System Device Summary shown on drawing E10.0 is to be the primary document used when designing the system.

PLEASE REFER TO THE MARKED DRAWINGS AND THE SECURITY DEVICE SUMMARY DOCUMENT FOR THE SPECIFIC SECURITY AND LOCKSMITHING REQUIREMENTS.

- .9 The Contractor shall supply all necessary wiring, termination equipment/devices and other necessary equipment not specified in the Contract Documents but which is necessary to implement a fully functional Lenel OnGuard security system and mechanical/electromechanical key lock system. Details for lock placement, function and keying can be found in the associated Security Device Summary drawing E10.0
- .10 All wires shall be CSA approved and have a flame test value equal to, or greater than, that required by the local building or fire code where it is being used, including the OBC.
- .11 End of line supervision shall be used on all installations. End of line resistors shall be installed at the detection device and not the control panel.
- .12 All devices should be installed with a continuous, splice free cable run.
- .13 If splices are required, the splices shall be made in OESC approved junction boxes. Splice box locations shall be marked on the wiring diagram.
- .14 Wire lists shall be permanently affixed inside the control panel.
- .15 Security wiring should not run in parallel within 12" of 110 V AC or higher voltage electrical wiring or conduit.
- .16 All applicable local, provincial or federal codes shall be followed.

- .17 The location of equipment shown on Drawings may be revised by the Consultant during construction, and the Contractor shall not be entitled to any additional costs for the relocation of equipment provide that the new the location is within 6 meters of original location.
- .18 Install transformers complete with mounting brackets and hardware in positions in accordance with the manufacturer's instructions.
- .19 The Contractor shall provide all necessary lugs and mounting equipment which is not already provided with transformers.
- .20 The facility to communicate with Lenel OnGuard database server at Region Headquarters via TCP/IP. Activation of switch/hub ports on networking equipment maintained by Region's Information Technology Services Group ("ITS") to be co-ordinated by the Region. Contractor to provide one (1) week prior notification to the ITS for activation of network ports.
- .21 IP addresses to be provided by Region upon request.
- .22 Network switch is to be located within the security system cabinet. Both modem and switch should be powered from UPS power supplies.
- .23 All replaced or extra equipment to be delivered to the Region upon project completion of this Contract to be used for spare parts.
- .24 Comply with all applicable ordinances when installing access control systems.
- .25 All manufacturers' requirements and electrical code requirements for grounding and bonding, including the requirements of the OESC and OBC, shall be followed.
- .26 Magnetic door contacts to be installed on all exterior access doors and interior doors, as identified within the Device Summary Chart on Drawing E10.0.
- .27 Electric door strikes to be installed on all doors as identified within the Device Summary on Drawing E10.0. Door key locks to allow key override of door strikes in all cases.

3.4 INSTALLATION – LENEL ONGUARD ENTERPRISE SOFTWARE INTEGRATION

- .1 Integrate the facility into the Region's existing Lenel OnGuard Enterprise software.
- .2 The Contractor shall co-ordinate the Work with the Region to incorporate facility into the Lenel OnGuard system.
- .3 This work shall be completed a minimum of 15 Working Days prior to the date of Substantial Performance of the Work. The Contractor to coordinate with the Region's Security and Life Safety Coordinator at 1-877-464-9675 ext. 76900.

3.5 OPERATION - GENERAL

- .1 Operation of the Lenel OnGuard security system to function similarly to existing Lenel OnGuard systems installed at Region Water and Wastewater and corporate facilities. The Contractor shall confirm all security system functions and operation with the Region of York Security and Life Safety Coordinator at 1-877-464-9675 ext.76900 prior to any programming.
- .2 Overview: A general overview of the operation of the system is as follows:
 - .1 The system shall allow for the monitoring of intrusion detection alarms inside the system alarm monitoring module, in addition to giving command and control of supported intrusion detection devices. Once alarms are brought in to the system they shall be stored in the system audit trail.
 - .2 All system events not designated as alarm conditions shall be stored in the system audit trail.
 - .3 Each door may be programmed to generate "Door Forced" and "Door Held Open" alarms. These alarms shall have the ability to have a user-definable time delay. Request to exit ("RTE") motion sensors to be installed on interior of all perimeter exit doors which are equipped with door contacts to prevent false forced entry caused by egress of personnel. RTEs to be configured to shunt forced entry only; RTEs shall not to be configured to release the electric strike mechanisms in place.
 - .4 The system shall upload/download information to the control panels automatically while the control panels are in communication with the host server application. A data download may also be initiated manually. This may consist of either controller database information or alarms and events.
- .3 Authentication to Lenel OnGuard System shall be via programmed Door Groups, Time Zones and Access Groups.
- .4 Main entry doors to be assigned Access Group "A".
- .5 HID Reader and combination HID Reader and Arming Button to function as a method of arming and disarming security system respectively. The system shall only Arm if there are no troubles in the system.
- .6 Upon presentation of proximity card identified as Region staff, the system shall activate electric door strike on a corresponding door, allowing those doors to be opened.
- .7 Upon authorized entry to facility (Assess Granted, Door opened) the system shall automatically disarm the system. "Security System Disarmed" input shall be signalled to field controller. Access granted without the door opening shall not disarm the system.
- .8 Prior to exiting facility, personnel will arm the security system by present their card to the interior "Arming" card reader and pushing "Confirm" pushbutton (Arming Button). This sequence of events will arm the security system. "Security System Armed" input shall be signalled to field controller. The action of breaking the door contact shall not to arm the security system. The system shall only Arm if there are no troubles in the system.

- .9 Upon manual key entry to armed facility, "Intrusion Alarm" input shall be signalled to field controller.
- .10 Upon illegal forced entry to facility, "Intrusion Alarm" input signalled to field controller. Control Panel maintains "Security System Armed" input signal to field controller.

3.6 FIELD QUALITY CONTROL

- .1 Cable and Wire – 1000 Volt and Below
 - .1 Conduct insulation resistance measurements using a "Megger" (500 V instrument for circuit up to 350 V system, 1000 V instrument for 351-600 V systems).
 - .2 Record test results in a log book and submit to the Consultant for reference. Replace or repair circuits which do not meet inspection Authority requirements. With equipment disconnected, measure insulation resistance of the following circuits:
 - .1 Power and lighting feeders: Phase-to-phase, phase-to-ground.
 - .2 Control circuits: To ground only.
 - .3 Do not perform "Megger" tests on equipment containing solid-state components.
 - .4 Disconnect power factor correction capacitors from system prior to testing.
- .2 Instrumentation Wiring
 - .1 Check continuity of each conductor using ohmmeter or DC buzzer. Megger or 120 volt filament lamp testing is not acceptable.
 - .3 Carry out functional tests with the Region's Representative to confirm field wiring, interlocks, and device functionality.
 - .4 Depending upon magnitude and complexity, divide security system into logical sections, energize one section at a time and check out operation of section.
 - .5 Upon completion of sectional tests, undertake group testing.
 - .6 Check out complete system for operational sequencing.
 - .7 For local testing, each device/sensor should be tested and marked off one by one until all devices/sensors are tested. Each sensor shall be verified to the zone.
 - .8 Submit to the Consultant one copy of all test results.
 - .9 Provide a written list of all passwords, keywords, serial numbers and/or configurations that are encountered during the installation of the operating system and application software. This information to be provided in writing to the York Region Security and Life Safety Coordinator at 1-877-464-9675 ext.76900.
 - .10 Assign all warranties, licenses and product registration to the Regional Municipality of York.

- .11 Turn over to the York Region Security and Life Safety Coordinator 1-877-464-9675 ext.76900 all installation software, user manuals, accessory cables, calibration units and any other material accompanying the installed equipment.

3.7 WIRING IDENTIFICATION

- .1 Identify all wiring including fibre optic cabling, with wire markers.
- .2 Colour code power, feeder and branch conductors at both ends with coloured plastic tapes. Tapes are not required where conductors are identified by jacket colour. Maintain phase and colour sequence throughout.
- .3 Identify each conductor, including spares, with a unique alphanumeric designation to facilitate troubleshooting and maintenance as identified by Region of York standards.
- .4 Identify all controller wiring at terminal blocks and connection points with the controller terminal (I/O) address numbers

3.8 SITE TESTING

- .1 Following installation of Lenel OnGuard System at the facility, Site testing shall be performed by the Contractor. Testing to be co-ordinated with the Region.
- .2 Record test results in a log book and submit to the Consultant for reference. Replace or repair circuits which do not meet inspection Authority requirements.
- .3 The Facility to be tested to confirm operation of the System
- .4 The Region's representative to be present for all testing. The Region's representative to confirm that testing has been satisfactorily completed and that system is ready for operational use as intended.
- .5 All facility exterior access doors to be tested for valid entry and intrusion entry by presentation of test proximity card(s) to reader. The corresponding inputs to SCADA system to be confirmed. The system to be tested with both valid and invalid proximity cards in online and offline operation modes.
- .6 All applicable doors to be tested for valid entry and intrusion entry. The corresponding inputs to SCADA system to be confirmed.
- .7 Key override to facility through main entry door to be tested for by manually opening door with mechanical key. Corresponding inputs to SCADA system to be confirmed.
- .8 Security system arming/disarming to be tested and verified.
- .9 All event and alarm conditions to be verified and logged to Lenel OnGuard database. To be verified by running a respective report.
- .10 Local testing to be performed at the facility. Following successful demonstration of local testing, operational testing to be performed utilizing Region's existing Lenel OnGuard Server.
- .11 Following successful integration with Lenel OnGuard Server, shift programming of the facility, if applicable, to be coordinated through the Region's Security and Life Safety Coordinator 1-877-464-9675 ext.76900.

END OF SECTION



EMS Shore Cord Assembly Instructions

These instructions are for the assembly of the EMS Shore Cord. They are to be followed to ensure we maintain the standard for our stock and installs.

Prepared By:
Tim Hywarren
Sr. Building Operator
Property Services Branch

Parts List

- To make complete assemblies from Power supply line to EMS Vehicle plug the following parts to be provided and installed by the electrical contractor:

Leviton Products:

Part#	Description	Qty.
69591-W3	3' cord set Wetguard Plug and connector	1
25W47 L5-15P	2 Pole, 3 wire Wetguard , Twist lock	1
25W47 L5-15R	2 Pole, 3 wire Wetguard , Twist lock	1

Hubbel Products:

HBL6018	Weatherproof Long Boot	1
HBL5269C	2 Pole, 3 wire Grounding	1

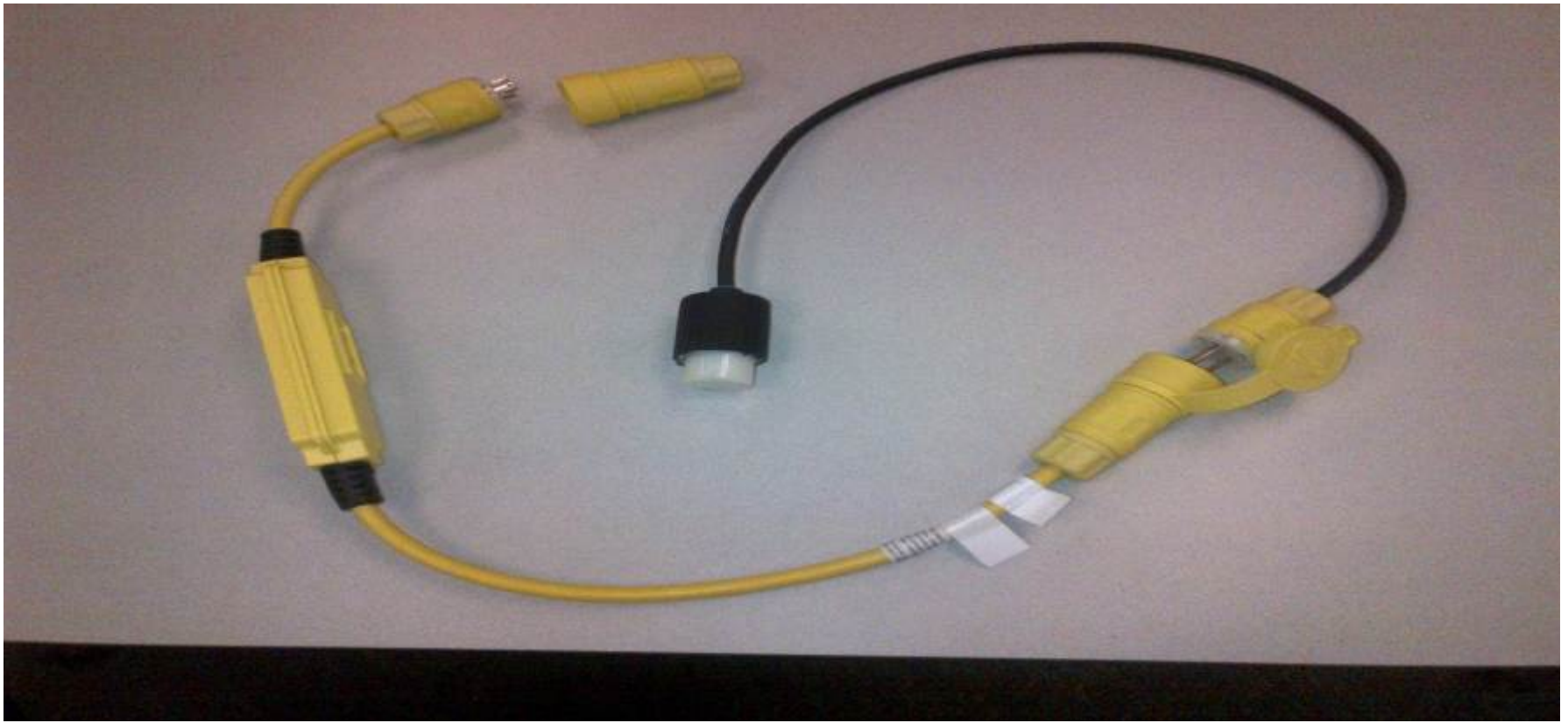
In House

35" 14/3 cabtire length	Qty	1
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Basic Configuration is:

[Twist lock] [Twist lock] [GFCI Assembly 6951-w3] [Whip aka Breakaway]

Pwr line – 24w47 female plug--24w47 male plug-- GFCI—14w47 female plug—14w47 male plug— Hubbel Boot



Supply Power

The supply line should have the following:

- Hanging from the ceiling with a strain relief on the cab tire
- The bottom of the 24w47 female Twist-Lock Wetguard plug at a height of **86"above the floor**



GFI Assembly



1. This is what it comes like from Manufacturer. It has a straight blade wetgaurd plug which needs to be replaced with a Twist Lock wetgaurd.



2. Disassemble the plugs end and remove only the straight blade portion. Then take a new Twistlock out of pkg and install it. The bases are interchangeable.



3. Once the new Twist Lock has been installed use a permanent marker to place inspection marks above the connections points to verify correct wire placement



4. Completed End

Whip End (Prep)

- Prior to making the Whip end some prep work needs to be done

Cabtire 14/3 cut to 35" length



Boot Top needs to be cut. Only the Top section needs to be removed. Use a Cable cutter to get best results



Whip Assembly



1. Remove 1" of cab tire casing & strip wires at each end



2. Install Wetgaord end, Mark the connection points w/ marker



3. Put the prepped boot on wire



4. Disassemble the Hubbell end



5. Slide the casing on wire length



6. Install Hubbell Plug, Mark Connection points w/ marker



7. Slide Hubbell boot over plug pulling it over plug end under it is seated firmly at the back of boot.

Whip Assembly (Boot Mods)



1. Boot needs to be cut back to expose the Hubbell Plug End

2. It is 2" front the cord end of the boots shoulder

3. For best clean cut results use a PVC tube/pipe cutter and have the edge up against the raised shoulder of the plug end of the booth.

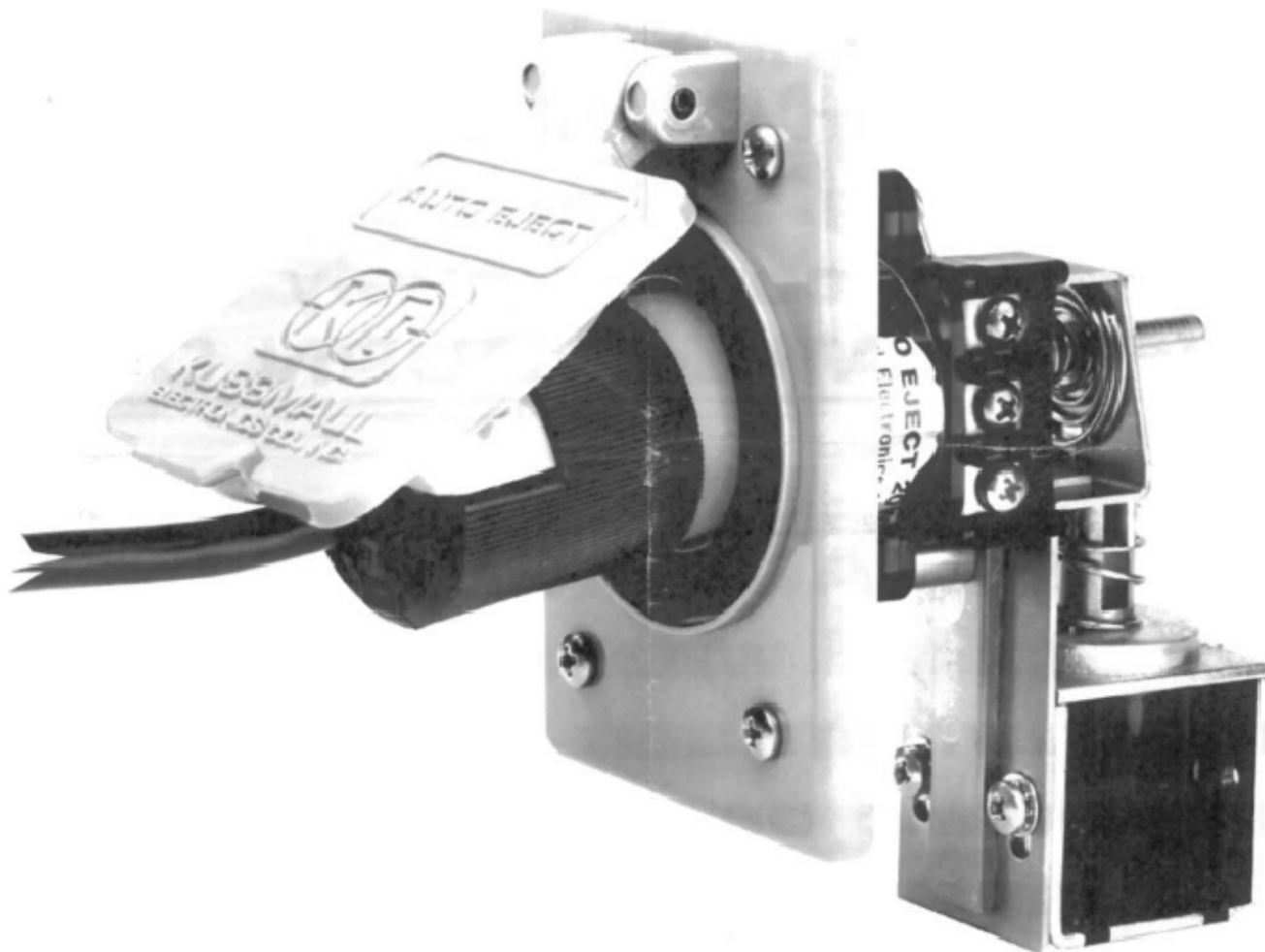
4. Using silicone seal around the cord and plug. This will help prevent water from entering the boot.



INSTRUCTION MANUAL

AUTO EJECT WP

AUTOMATIC SHORE LINE DISCONNECT



2 YEAR WARRANTY

170 Cherry Avenue
West Sayville, NY 11796
www.kussmaul.com

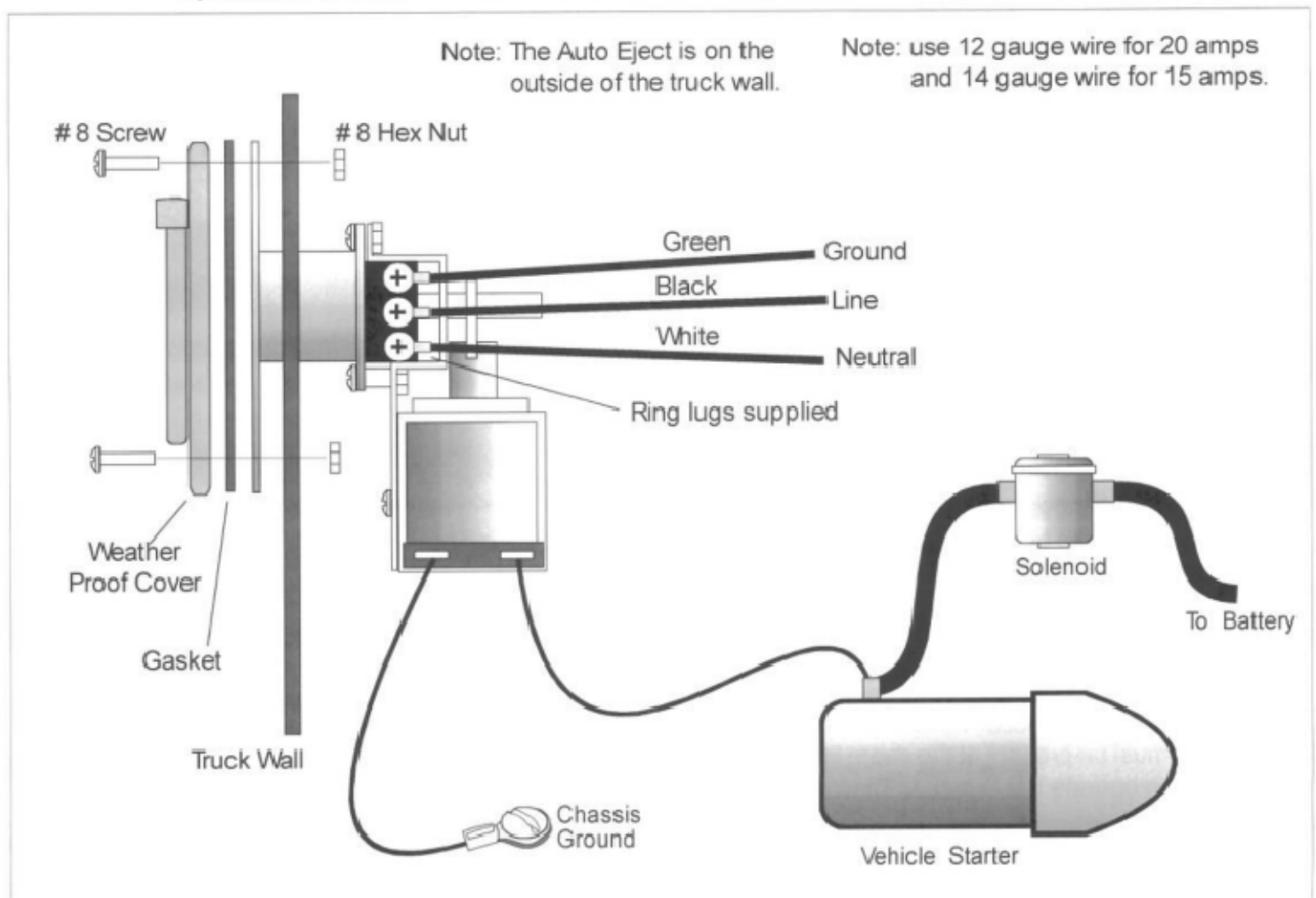
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ELECTRONICS
ENERGIZED AND READY, WHEN SECONDS COUNT

Ph: 800-346-0314
Fax: 631-567-5826
sales@kussmaul.com

INSTALLATION INSTRUCTIONS

1. Locate a convenient place on the vehicle to mount the AUTO EJECT. A minimum clearance of 4" behind the mounting panel is required as well as 3 3/4" below the center line to clear the ejection mechanism.
2. Place the template in position and center punch in 7 places.
- 3a. Drill 2 holes, 1/2" diameter. IMPORTANT THESE HOLES MUST BE DRILLED FIRST.
- 3b. Drill 4 mounting holes, 3/16" diameter and one, 2 1/4" clearance hole for the AUTO EJECT.
4. Connect one terminal of the solenoid on the AUTO EJECT to the vehicle ground and the other solenoid terminal to the vehicle's starter. USE #16 GAUGE WIRE OR HEAVIER.
5. Crimp the ring lugs on the wire and connect the Green, Black, and White power wires to the accessories on the vehicle.
6. Test installation by installing mating connector into the AUTO EJECT. Energizing the starter should energize the solenoid and eject the connector.
7. Keep connector and contacts of the AUTO EJECT clean. Clean contacts with WD-40 solvent as required. Lubricate contacts monthly with "vaseline" to insure free operation.

NOTE: USE ONLY CORD CONNECTOR SUPPLIED WITH THE AUTO EJECT
All connectors are not identical, using a substitute may result in unreliable operation or failure of the AUTO EJECT to operate.



INSTALLATION RECORD & WARRANTY

Date Installed _____

Installed By _____

Vehicle Identification _____

Vehicle Owner _____

2 YEAR WARRANTY

All Auto Ejects manufactured by Kussmaul Electronics Company Inc. are warranted to be free of defects of material or workmanship. Liability is limited to repairing or replacing at our factory, without charge, any material or defects which become apparent in normal use within 2 years from the date the equipment was shipped. Equipment is to be returned, shipping charges prepaid and will be returned, after repair, shipping charges paid.

This warranty does not include normal wear and tear, pitting of the electrical contacts, malfunction due to contamination of the mechanism, or solenoid overheating due to improper installation.

Kussmaul Electronics Company, Inc. shall have no liability for damages of any kind to associated equipment arising from the installation and /or use of the Kussmaul Electronics Company, Inc. products. The purchaser, by the acceptance of the equipment, assumes all liability for any damages which may result from its installation, use or misuse, by the purchaser, his or its employees or others.

1. EMS SHORE CORD ASSEMBLY INSTRUCTIONS

1.1 PARTS LIST

To make complete assemblies from Power supply line to Emergency Medical Services Vehicle plug, the Contractor shall ensure that the following parts are provided and installed by the electrical Subcontractor:

Leviton Products:

Part#	Description	Qty.
69591-W3	3' cord set Wetguard Plug and connector	1
25W47 L5-15P	2 Pole, 3 wire Wetguard , Twist lock	1
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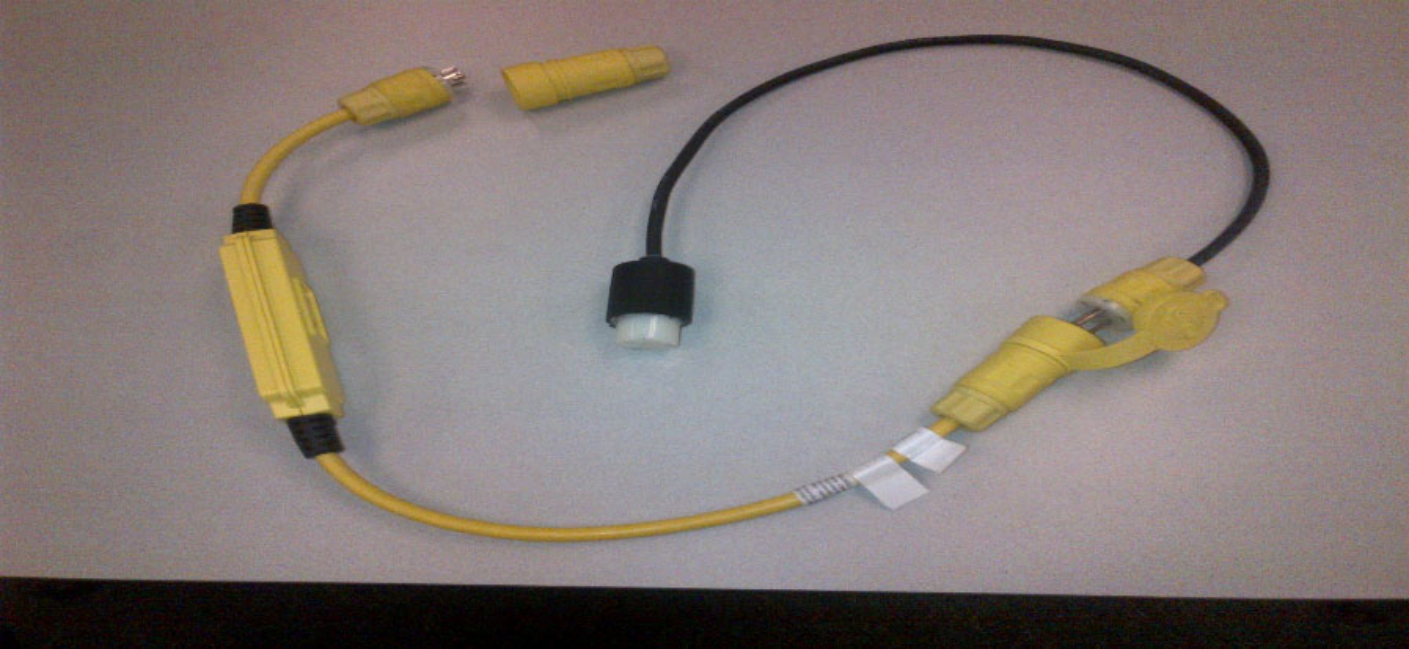
Or equivalent

Owner will provide
35" 14/3 cabtire length Qty 1

Or equivalent

1.2 Basic Configuration is:

[Twist lock] [Twist lock] [GFCI Assembly 6951-w3] [Whip aka Breakaway]
Power line – 24w47 female plug--24w47 male plug-- GFCI—14w47 female plug—14w47 male plug— Hubbel Boot



1.3 The Supply Line Shall Have The Following:

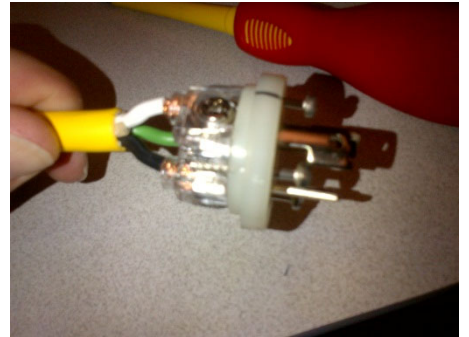
- Hanging from the ceiling with a strain relief on the cab tire
- The bottom of the 24w47 female Twist-Lock Wetguard plug at a height of 86" above the floor.



1.4 GFI Assembly:



1. This is what it comes like from manufacturer. It has a straight blade wetgaud plug which needs to be replaced with a Twist Lock wetgaud.



2. Disassemble the plugs end and remove only the straight blade portion. Then take a new Twistlock out of package and install it. The bases are interchangeable.

3. Once the new Twist Lock has been installed use a permanent marker to place inspection marks above the connections points to verify correct wire placement



4. Completed End

1.5 Whip End (Preparation):

- Prior to making the Whip end some preparation work needs to be done

Cable 14/3 cut to
35" length



Boot Top needs to be cut. Only the Top section needs to be removed. Use a Cable cutter to get best results





1. Remove 1" of cab tire casing & strip wires at each end



2. Install Wetgaord end, Mark the connection points w/ marker



3. Put the prepped boot on wire



4. Disassemble the Hubbell e



5. Slide the casing on wire length



6. Install Hubbell Plug, Mark Connection points w/ marker



7. Slide Hubbell boot over plug pulling it over plug end under it is seated firmly at the back of boot.



1. Boot needs to be cut back to expose the Hubbell Plug End



2. It is 2" front the cord end of the boots shoulder



3. For best clean cut results use a PVC tube/pipe cutter and have the edge up against the raised shoulder of the plug end of the booth.



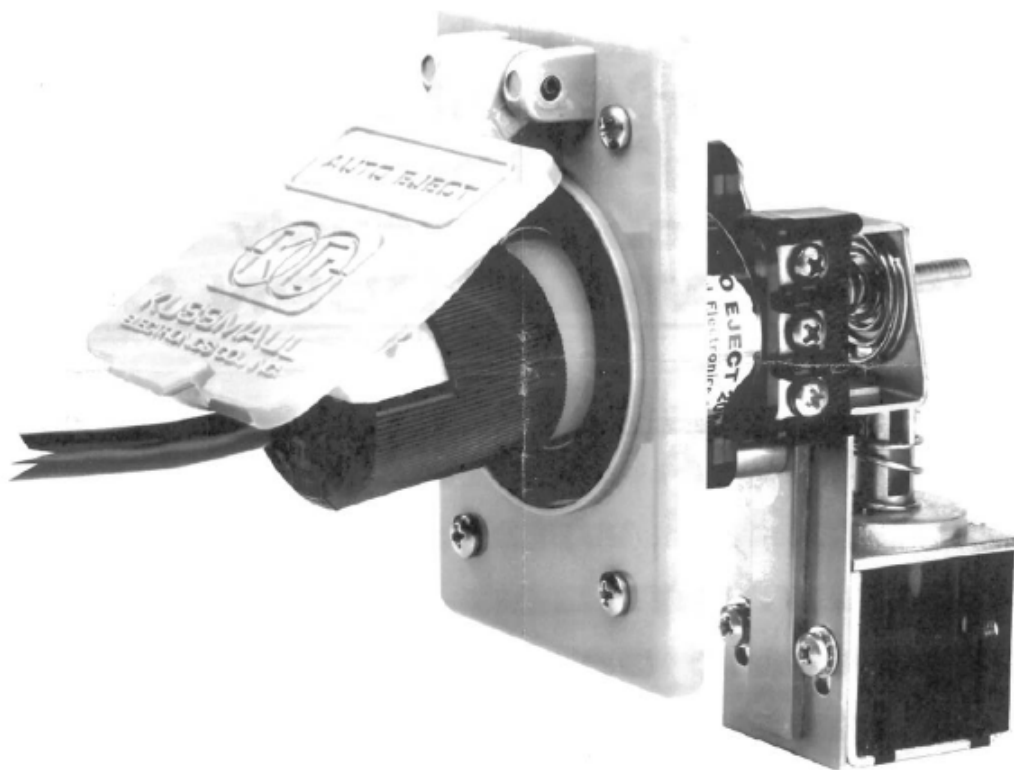
4. Using silicone seal around the cord and plug. This will help prevent water from entering the boot.



FILE: D91-18wp rev d
Rev: D, DATE: 1-19-12

INSTRUCTION MANUAL

AUTO EJECT WP AUTOMATIC SHORE LINE DISCONNECT



2 YEAR WARRANTY

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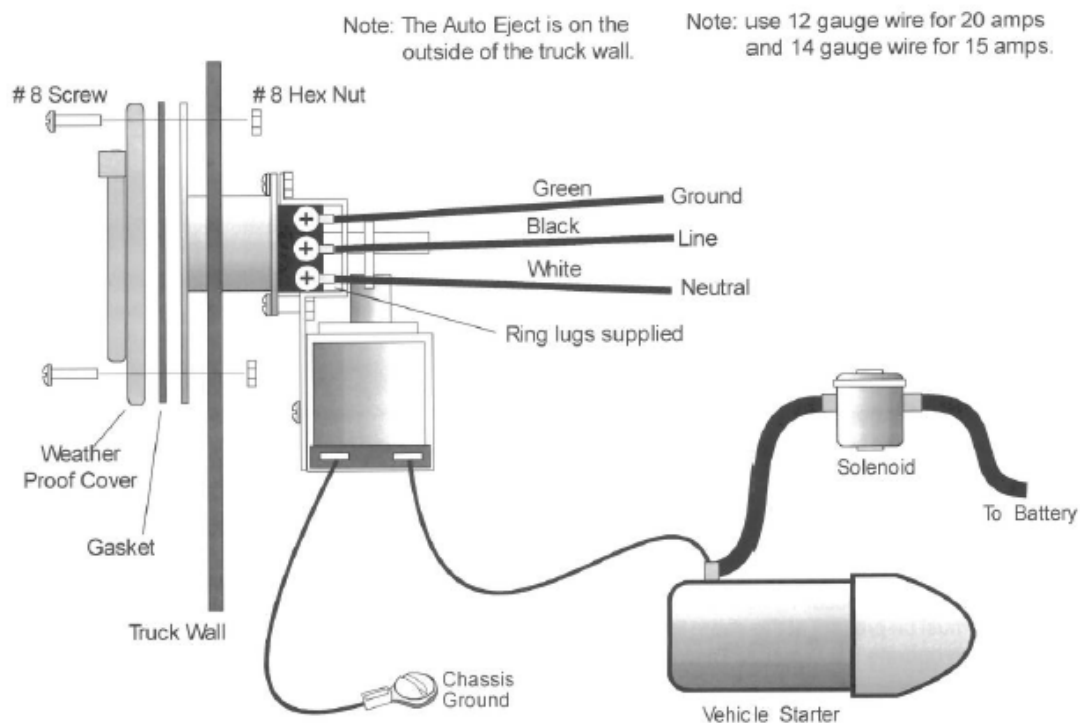
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END OF SECTION