

# **PROJECT MANUAL VOL. 2**

Issued for Tender

Mechanical and Electrical

**Vaughan Fire Station 7-12**

**T24-253**

9511 Weston Road, Vaughan, ON

# **Mechanical Specifications**

**City of Vaughan Fire Station No. 7 - 12**

**Project No. 2104  
JSC Project No. 21-237**

**Issued for Tender**

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TABLE OF CONTENTS

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CONTENTS

<u>SECTIONS</u>	<u>TITLE</u>
21 05 01	Mechanical General Requirements
21 07 00	Insulation
21 13 00	Fire Protection
22 05 00	Plumbing & Drainage
23 05 93	Testing, Adjusting, Balancing
23 21 00	Liquid Heat Transfer
23 31 00	Air Distribution
25 90 00	Building Automation System

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MECHANICAL GENERAL REQUIREMENTS

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
<u>PART 1 - GENERAL</u>	
1.1	Related Division
1.2	Sustainable Design Requirements
1.3	Tenders
1.4	Subtrades
1.5	Workmanship Standards
1.6	Drawings
1.7	Job Site Work Shop and Storage
1.8	Protection
1.9	Record Documents
1.10	Instructions to Operator
1.11	Intent
1.12	Alternates & Substitutions
1.13	By-Laws & Permits
1.14	Co-Operation & Co-Ordination
1.15	Temporary or Trial Usage
1.16	Liability
1.17	Shop Drawings
1.18	Codes and Standards
1.19	Warranty
<u>PART 2 - PRODUCTS</u>	
2.1	Electrical Equipment
2.2	Motors Starters & Controls
2.3	Hangers
2.4	Access Doors
<u>PART 3 - EXECUTION</u>	
3.1	Installation
3.2	Electrical Work
3.3	Cutting & Patching
3.4	Excavating
3.5	Backfilling
3.6	Supports
3.7	Flashings

... Continued

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MECHANICAL GENERAL REQUIREMENTS

---

CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
<u>PART 3 - EXECUTION</u>	
3.8	Hangers
3.9	Sleeves
3.10	Levels & Dimensions
3.11	Painting
3.12	Equipment Markers & Nameplates
3.13	Pipe Identification
3.14	Cleanup
3.15	Valve Tags & Chart
3.16	Pipe and Valve Identification Table
3.17	Cold Weather Work
3.18	Floor & Wall Plates
3.19	Work Schedule
3.20	Shop Drawings
3.21	Examine Site & Conditions
3.22	High Efficiency Motors

---

**MECHANICAL GENERAL REQUIREMENTS**

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**PART 1 - GENERAL**

**1.1 RELATED DIVISION**

- .1 Division One, General Requirements is part of this Section and shall apply as if repeated here.
- .2 Unless specified otherwise, this Section shall apply to all Sections of Mechanical Division.

**1.2 SUSTAINABLE DESIGN REQUIREMENTS**

- .1 Material and products under work of this Division are to comply with Sustainable Design Requirements provided in Division 1 Section 01 35 20, 01 35 50, 01 35 90 and 01 61 10.

**1.3 TENDERS**

- .1 Submit tender based on specified described equipment or Alternates listed.

**1.4 SUBTRADES**

- .1 Subcontractors named at the time of Tender or substitutions authorized by the Owner will be recognized as being in accordance with the Contract and any payments will be approved by the Owner, only to such Subcontractors.
- .2 The Owner may, for reasonable cause object to the use of a proposed Subcontractor and consequently, may require the Mechanical Contractor to employ one of the other Subcontractor bidders.
- .3 In the event that the Owner requires a change from a proposed Subcontractor originally proposed by the Mechanical Contractor, the Contract Price shall be adjusted by the difference in cost.
- .4 The Mechanical Contractor shall not be required to employ as a Subcontractor, a firm to whom he may reasonably object.

**1.5 WORKMANSHIP STANDARDS**

- .1 Workmanship and method of installation shall conform to best standards and practice. Where required by local or other By-Laws and Regulations, tradesmen shall be licensed in their trade.

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## MECHANICAL GENERAL REQUIREMENTS

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### 1.6 DRAWINGS

- .1 Mechanical drawings do not show structural and related details. Take information involving accurate measurement of building from building drawings, or at building. Make, without additional charge, any necessary changes or additions to runs of piping, ducts or equipment locations to accommodate structural conditions. Location of piping, ducts, controls and equipment may be altered by Architect without extra charge provided change is made before installation and does not necessitate major additional material. Do not scale drawings.
- .2 Relocate equipment and/or material installed but not coordinated with work of other Sections as directed, without extra charge.
- .3 Furnish "built-in" items in ample time and give necessary information and assistance in connection with building-in of same. Notify Section concerned in writing of size and location of recesses, openings and chases at least 48 hours before walls are erected, floors poured and similar work.
- .4 Before commencing work, check and verify all sizes, locations, materials, elevations, levels and dimensions to ensure proper and correct installation. Verify existing and municipal services.

### 1.7 JOB SITE WORK SHOP AND STORAGE

- .1 Supply job site office, workshop, tools, scaffolds and material storage as required to complete the work of this Division. Location of temporary buildings, use of space on site or within building shall be to later direction.

### 1.8 PROTECTION

- .1 Securely plug or cap open ends of pipes, ducts or equipment to prevent entry of dirt, dust, debris, water, snow or ice. Clean all piping, ducting and equipment inside and outside before testing.
- .2 Equipment stored on site shall be protected from weather and kept dry and clean at all times. Take care to avoid corrosion of metal parts. Protect all bearings and motors from damage due to moisture and dust. Equipment not yet in operation shall be turned over at least at monthly intervals to prevent bearing deterioration.
- .3 Protect work installed from damage. Secure all unfinished or loose work to prevent movement.

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## MECHANICAL GENERAL REQUIREMENTS

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### 1.9 RECORD DOCUMENTS

- .1 Conform to General Requirements. Maintain at least 2 sets of documents and clearly mark on same as job progresses, changes and deviations from work shown so that on completion Owner will have records of exact location of ducts and equipment and record of material and equipment changes.
- .2 Contractor shall obtain clean set of prints from Consultant at start of Contract Work and shall keep these prints up-to-date at jobsite, accurately recording all changes made on project and locating all services, equipment, etc. which may have been shown only diagrammatically on Contract Documents.
- .3 Contractor shall ensure that as-built information is accurately recorded and shall check same. As-Built drawings shall be reviewed with Consultant at each jobsite meeting.
- .4 Upon completion of Contract Work, prior to Substantial Performance inspection and after final review with Consultants, Contractor shall issue to the Consultant for review the actual on site As-Built Drawings. Upon acceptance Contractor shall neatly transfer recorded information and make final As-Built submission to Consultant for review in the following form:
  - One (1) set of clean, legible prints.
  - One (1) ACAD 2019 format drawings. Files shall retain all setting (layers, line types, scales colors, etc) as used in the drawing files (produced) by consultant.
- .5 After Record Drawings have been reviewed, revised if necessary until acceptable to the consultant. Deliver drawings in the form of CD (CAD + PDF) and three (3) sets of prints taken from that CD to Owner.

### 1.10 INSTRUCTIONS TO OPERATOR

- .1 Instruct Building Operators in repair, maintenance and operation of Mechanical Systems and associated equipment.
- .2 Supply two sets of full Operation and Maintenance Instructions each in stiff cover, three-ring binder suitably indexed, separated and labeled. Operate each item of equipment in presence of Operators to ensure understanding of working parts and function of each item of equipment. Supply one complete set of "Reviewed" Shop Drawings in separate hard cover binder suitably separated and labeled for the Owner's use.
- .3 Operation and maintenance manuals shall be carefully prepared in co-operation with equipment manufacturers and include miscellaneous parts necessary for proper, efficient operation of all equipment; and shall ALSO identify routine maintenance required on all items.



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## MECHANICAL GENERAL REQUIREMENTS

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### 1.11 INTENT

- .1 Mention herein or indication on drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated: and, performance of each operation prescribed with furnishing of necessary labour, equipment, and incidentals for mechanical work, Mechanical Division.
- .2 Where used, words "Section" and "Division" shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.
- .3 Where used, word "supply" shall mean furnishing to site in location required or directed complete with accessory parts.
- .4 Where used, word "install" shall mean secured in place and connected up for operation as noted or directed.
- .5 Where used, word "provide" shall mean supply and install as each is described above.
- .6 Where used, wordings such as "approved, to approval, as directed, permitted, permission, accepted, acceptance, report to", shall mean "approved, directed, permitted, accepted, report to", by the Consultant.

### 1.12 ALTERNATES & SUBSTITUTIONS

- .1 Throughout Mechanical Division are lists of "Alternate Equipment" manufacturers acceptable to Consultant if their product meets characteristics of specified described equipment. See attached Supplementary Tender Form and comply with same.
- .2 Each Bidder may elect to use "Alternate Equipment" from lists of Alternates where listed. Include for any additional costs to suit Alternates used. Prices are not required in Tender for Alternates listed except where specifically noted as "Separate Price".
- .3 It is responsibility of this Division to ensure "Alternate Equipment" fits space allotted and gives performance specified. If an "Alternate Equipment" unit is proposed and does not fit space allotted nor equal specified product in Consultant's opinion, supply of specified described equipment will be required without change in Contract amount. Only manufacturers listed will be accepted for their product listing. All other manufacturers shall be quoted as substitution stating conditions and credit amount.

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## MECHANICAL GENERAL REQUIREMENTS

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- .4 It item of material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after Contract has been awarded.
- .5 If pipe or item, of size or weight indicated, is unobtainable, supply next larger size or heavier weight without additional charge.

### 1.13 BYLAWS & PERMITS

- .1 Obey Government, Municipal and Underwriters Standards and perform work in accordance with requirements of By-Laws and Regulations in force where building is located.
- .2 Apply for, obtain, and pay for permits and inspections required by authorities having jurisdiction. Furnish necessary certificates as evidence that work installed conforms with laws and regulations of authorities having jurisdiction. Make minor changes required by By-Laws and Regulations of authorities having jurisdiction without extra payment.
- .3 Plumbing and Heating permits form part of Building Permit. Costs of these permits will be paid for as part of overall Building Permit and are not chargeable to this Division.

### 1.14 CO-OPERATION & CO-ORDINATION

- .1 Each Section and Trade shall:
  - .1 Confer with other Sections and arrange work so it will be carried on in best interests of all concerned bearing in mind building construction and finish required.
  - .2 Furnish "built-in" items in ample time and give necessary information and assistance in connection with building-in of same. Notify Section concerned in writing of size and location of recesses, openings and chases at least 48 hours before walls are erected, floors poured and similar work.
  - .3 Proceed as quickly as practical so that construction may be complete in shortest possible time.

### 1.15 TEMPORARY OR TRIAL USAGE

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

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## MECHANICAL GENERAL REQUIREMENTS

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- .2 For temporary use of equipment to heat the building activate air system under direction of Engineer to provide temporary heat after Engineer is satisfied that system will not be damaged by freezing. Protect ducting system by disposable filters 50% effective NDS inspected daily and replaced as necessary. Finally, vacuum clean entire ducting system and replace filters.

### 1.16 LIABILITY

- .1 Each Section and Trade shall:
  - .1 Assume full responsibility for laying out his work and for any damage caused to other Sections by improper location or carrying out of same.
  - .2 Be responsible for prompt installation of work in advance of concrete pouring, ceiling installation or similar work.
  - .3 Protect finish and unfinished work of this Division and work of other Sections from damage due to work of this Division.
  - .4 Be responsible for condition of material and equipment supplied. Be responsible for protection and maintenance of work completed until termination and acceptance.

### 1.17 SHOP DRAWINGS

- .1 Submit for review within 30 days of Contract award, 9 copies of Shop Drawings and Room Equipment Schedules covering material to be supplied.
- .2 Each Shop Drawing must be certified correct by submitting trade before submission. Shop Drawings not so certified will be rejected.
- .3 Submit Shop Drawings for review for accordance with Division 1. Make printed submissions of more than two pages in booklet form. Failure to conform may cause undue delay in approvals.
- .4 Review of Shop Drawings is for sole purpose of ascertaining conformance with general design concept. This review shall not mean that Engineer approves detail design inherent in Shop Drawings, responsibility for which shall remain with Contractor and such review shall not relieve Contractor of his responsibility for errors or omissions in the Shop Drawings or of his responsibility for meeting all requirements of Contract Documents.

Contractor is responsible for dimensions to be confirmed and correlated at site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of work of all trades.

## MECHANICAL GENERAL REQUIREMENTS

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- .5 Shop drawings shall have manufacturers names, or supplier's name complete with phone numbers and names of contacts, catalogue model numbers, name of trade supplying same, identification number, all pertinent selection criteria such as air flow, noise, heat input/output, etc. otherwise they shall be returned.
- .6 The contractor shall not have equipment delivered to site until a shop drawing for the item has been reviewed and approved.
- .7 Equipment layout drawn to scale including piping accessories to show clearance for operating and servicing for:
  - .1 Pumps including pump characteristics curves;
  - .2 Plumbing fixtures, cuts, trim and fittings roughing dimensions;
  - .3 Floor drain and roof drain details;
  - .4 Fan with performance curves stating air quantities, external static pressures, outlet velocities, top speeds, fan rpm, discharge arrangement, class construction weights and all motor data;
  - .5 Air Handling units and their control systems;
  - .6 Louvres, grilles, registers and diffusers;
  - .7 Temperature Controls.
- .8 In addition, electric wiring diagrams, control panel boards, motor test data, motor starters and controls for electrically operated equipment furnished by Mechanical trades must also be included.

### 1.18 CODES AND STANDARDS

- .1 Installation must comply with latest editions and all amendments of the following codes and standards. Where conflicts in requirements occur the higher standards will apply:
  - .1 Ontario Building Code;
  - .2 Canadian Standards Association;
  - .3 Canadian Gas Association;
  - .4 National Building Code of Canada;
  - .5 The Building Code (Ontario);
  - .6 All governing municipal requirements;
  - .7 Canadian Heating, Ventilating and Air Conditioning Code;
  - .8 Canadian Plumbing Code;
  - .9 Regulation 815/84 respecting plumbing made in the Ontario Water Resources Act;
  - .10 Section 41 and 42, regarding provision of sewers and water mains, Ontario Regulation 54/76, the Ontario Water Resources Act;
  - .11 Underwriters' Laboratories of Canada Standards;
  - .12 Ontario Electrical Codes;
  - .13 Ontario Occupational Health and Safety Act;

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## MECHANICAL GENERAL REQUIREMENTS

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- .14 Conservation Authority;
- .15 Ministry of the Environment;
- .16 National Standards of Canada;
- .17 Canadian General Standards Board;
- .18 American National Standards Institute;
- .19 American Society of Testing and Materials;
- .20 Local Fire Codes;
- .21 Provincial Ministry of Labour

### 1.19 WARRANTY

- .1 Furnish to the Owner through General Contractor and Consultant, written warranty covering materials and workmanship and free service for one year from date of start of substantial performance.
- .2 Warrant apparatus installed to properly operate, cool, heat and ventilate without undue noise through every item of equipment and system and to maintain required room conditions.
- .3 Warranty shall entail repair or replacement of materials installed without charge to the Owner except where, in opinion of Consultant, such repair or replacement was caused by improper use or lack of proper maintenance.

## **PART 2 - PRODUCTS**

### 2.1 ELECTRICAL EQUIPMENT

- .1 Electrically operated equipment shall be C.S.A. approved and bear approval label. Special Inspection label of Ontario Hydro will be accepted in lieu of C.S.A. approval label.
- .2 Electrically operated equipment, starters and controls shall be rated for satisfactory operation on following nominal voltages unless otherwise noted:
  - Up to and including 0.25 kw - 60/1/120 V
  - 0.37 kw and larger - 60/3/208 V or as noted
- .3 Verify characteristics of all electrical components with Electrical Division before submitting Shop Drawings for processing.
- .4 Electrical interlocks and control devices shall operate on 120 volts A.C. maximum. Provide necessary fused and grounded control transformer to suit as necessary. All control circuits shall be fused and grounded.

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## MECHANICAL GENERAL REQUIREMENTS

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- .5 Unless otherwise noted motors shall be O.P.D. shielded ball bearing, EEMAC Specification MG-1, Design B, 1.15 service factor, Class 130 of Canadian Manufacture with local service available, be rated for satisfactory operation on noted utilization voltages and bear proper nameplate. Electric motor operated equipment shall have motor sized to bring unit to full operating r/s in ten seconds unless unit is equipped with integral thermal device to prevent motor burnout. Motors shall be 30 r/s synchronous unless otherwise noted.

### 2.2 MOTOR STARTERS & CONTROLS

- .1 Mechanical Division shall provide all motor starters and associated controls required and as scheduled on drawings and noted for Mechanical Division equipment. Starters and controls shall be Canadian General Electric or Alternate noted. All starters, contactors, thermal overloads, etc. must be EEMAC rated. All starters shall be of one manufacturer except as specifically approved otherwise for integral pre-wired assemblies.
- .2 Starter and control units shall be equipped with necessary number of auxiliary contacts and relays to provide control sequences described in Mechanical Equipment Starter Schedule on Drawings. Auxiliary contacts shall be interchangeable normally open or normally closed, by conversion in field without additional parts exterior to starter.
- .3 Manual starters may only be provided for single-phase equipment operated by control device such as thermostat or limit control when such control device is rated for full electrical load of equipment.
- .4 Manual starters provided for single phase equipment actuated by electric timer or shall have H.O.A. feature. "Hand" position shall permit shunting of time switch. Where such units also have protective device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" positions and shall not be shunted.
- .5 Manual starters may only be provided for three phase equipment which is not actuated by pilot control device (pressure switch, float switch, safety limit devices, remote manual control device) unless otherwise noted in Starter Schedule.
- .6 Magnetic starters for manually operated equipment shall have "On/Off" selector switch or "Start-Stop" pushbutton in cover as scheduled.
- .7 Magnetic starters which are started automatically by electric time switch shall include "Hand-Off-Automatic" (H.O.A.) selector switch. "Hand" position shall permit shunting of time switch or E.M.S. Where such units also have protective pilot device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" position and shall not be shunted.

### MECHANICAL GENERAL REQUIREMENTS

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- .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.

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MECHANICAL GENERAL REQUIREMENTS

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- .14 "Double Voltage Relays" shall be CGE Model CR120 LXMC with general purpose enclosure, number of contacts required and "Mylar" shroud of enclosure of contacts, or approved equivalent.
- .15 Pilot devices such as "Start-Stop" pushbuttons, "Hand-Off-Auto" selector switches and indicating lights shall be of heavy-duty construction. Indicating lamps shall be transformer type incandescent with amber safety lens caps.
- .16 Each control unit shall be provided with engraved nameplates for designation of device controlled and duty. See Subsection "Equipment Markers & Nameplates" for details.
- .17 Control wiring shall be 120 volt A.C. maximum. Provide control circuit transformers where these are not included in motor starters. Secondaries of control transformers shall be fused with one side grounded and controls, safety devices and interlocks shall be connected in ungrounded conductor, excepting only integral starter overload devices.
- .18 Single phase motors interlocked to start or operate with other equipment shall be provided with magnetic starters or suitable relays with necessary auxiliary contacts and double voltage relays or be otherwise electrically separated.
- .19 Overload relay heaters for starters shall be selected and field adjusted to trip at maximum value of 115% of actual nameplate full load amperes. Selection of heater elements shall be based on starter manufacturer's recommendations. Obtain data from Mechanical Division. Submit Motor Starter Schedule which shall list following for each motor:
  - Proposed equipment nameplate data
  - Actual full load amperes of motor
  - Speed of motor
  - Temperature Class in degrees Celsius rise and insulation class.
  - Circuit breaker or fuse type and proposed rating
  - Type of motor, duty and service factor.
- .20 Overload relay heaters shall trip in 20 seconds or less from cold or motor-locked rotar condition.
- .21 Where equipment is noted to be electrically interlocked, provide necessary interlocks, double voltage relays (Mylar shroud accepted) to provide specified operation.



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## MECHANICAL GENERAL REQUIREMENTS

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- .22 Provide all fuses required to protect equipment. Fuses shall be proper size blade type time delay HRC1-J current limiting. Supply three spare fuses of each size and type and obtain duplicate receipt for same. Fuse clips shall reject standard NEC fuses. Fuses shall be rated in accordance with manufacturer's published data. Fuses to be of one manufacturer throughout.
- .23 Acceptable Alternate Manufacturers
1. Furnas Electric
  2. Westinghouse
  3. Allen Bradley
  4. Square 'D'
  5. Cutler Hammer
  6. Klockner-Moeller.
  7. Commander
  8. Telemecanique

### 2.3 HANGERS

- .1 Pipe hangers shall be Myatt or Grinnell equal as follows:
- .1 For horizontal ceiling supported: Myatt #124 split clevis or Grinnell #260.
  - .2 For horizontal wall supported: Myatt #157 offset wall.
  - .3 For vertical piping: Myatt #182 riser clamp or Grinnell #261.
  - .4 For insulation shield: Myatt #251 galvanized steel or Grinnell #167.

### 2.4 ACCESS DOORS

- .1 Supply as required, 12 gauge hinged metal access doors with frames for installation by other Sections in walls or ceilings to permit access to built-in or inaccessible controls, dampers, valves, cleanouts and components.
- .2 Access doors shall be Stelpro Ltd. #722 flush type of size to suit controls, valves, cleanouts, dampers or components serviced, minimum size 300 x 300 mm "Reach-In", 300 x 600 mm "Crawl-In", with prime coat finish, concealed hinges, screwdriver lock and plaster key. Access doors in finished masonry or drywall construction shall be #722 less plaster key. Access doors shall be #726 in acoustic tile ceilings and #704 in drywall ceilings.
- .3 Access doors in fire rated walls, duct shafts or in corridor walls shall be UL, ULC or WHI listed 1-1/2 hour fire rated access doors equal to LeHage #L1010, Nailor Hart #0900 or Acudor #150B with screwdriver lock.

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MECHANICAL GENERAL REQUIREMENTS

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- .4 Access doors in fire rated ceiling assemblies, all fire rated walls, duct shafts or in corridor walls shall be UL, ULC or WHI listed 1-1/2 hour fire rated access doors equal to LeHage #L1010, Nailor Hart #0900 or Acudor #150B with screwdriver lock.
- .5 Alternate Equipment:
  - 1. Smille, McAdams & Summerline Ltd.
  - 2. Mifab (Modular Equipment Mfg. Inc.)
  - 3. Can-Aqua Inc.
  - 4. Acudor Products Ltd.
  - 5. LeHage (Ancon Industries Ltd.)
  - 6. Nailor Hart Industries Inc.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- .1 Instruct and supervise other Sections doing related work. Co-ordinate all work between this Division and their relationship to all other Sections. Supply measurement of equipment to other Sections to allow for necessary openings to be left in work of other Sections.
- .2 Install all work and equipment to manufacturer's printed directions.
- .3 Install furred-in work neatly and close to building structure so furring will be as small as practical.
- .4 Supply measurements of equipment, duct openings and recesses to other Sections to allow for necessary openings to be left in work of other Sections for work of this Division.
- .5 Install pipes and ducts to clear structural members and any fireproofing. Locate mechanical work to permit installation of specified insulation. Do not remove or damage structural fireproofing. Leave space to permit fireproofing and insulation to be inspected and repaired.
- .6 Install work in advance of concrete pouring, ceiling installation, furring or similar work.
- .7 Mechanical drawings indicate general location of route of pipes and ducts which are to be installed. Where required work is not shown or only shown diagrammatically, install same to conserve head room (minimum 2200 mm clear) and interfere as little as possible with free use of space through which they pass.

## MECHANICAL GENERAL REQUIREMENTS

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- .8 Relocate equipment and/or material installed but not coordinated with work of other Sections as directed, without extra charge.
- .9 Where lift-out acoustic board ceilings are used for access to components in ceiling space, boards shall be secured with accessible hold-down clips and marked with Bildemup #6RH brass paper fasteners inserted through boards and bent over. Paint heads with red enamel before installation.
- .10 As work progresses and before installing heating units, registers, diffusers, fixtures and other fittings and equipment which may interfere with interior treatment and use of building, obtain detail drawings or directions for exact location of such equipment and fittings.
- .11 Locate all mechanical and electrical equipment in such a manner as to facilitate easy and safe access to and maintenance and replacement of any part.
- .12 In every place where there is indicated space reserved for future or other equipment, leave such space clear, and install piping and other work so that necessary installation and connections can be made for any such apparatus. Obtain instructions wherever necessary for this purpose.

### 3.2 ELECTRICAL WORK

- .1 Electric connections and wiring for equipment supplied under Mechanical Division will be by Electrical Division except for Temperature Controls System, Mechanical Firing Equipment, and where otherwise noted. Provide electric wiring to complete all systems. All electrical work must conform to conditions noted in Electrical Division and be concealed except in service areas. All wiring MUST be in conduit or EMT using #18 wire for 24 volt or less, #14 wire for 120 volt control and #12 wire for 120 volt power wiring. Use wiremold where exposed in finished areas.
- .2 Supply necessary Shop Drawings of powered equipment to Electrical Division. Arrange piping, ductwork and equipment to permit access to and mounting of starters and controls. Co-operate with Electrical Division to ensure electrical equipment can be installed and serviced. See Electrical Drawings.
- .3 Control and operation of motors shall be in accordance with diagrams included in Electrical Division. Mechanical Division shall co-ordinate and confirm control functions supplying appropriate wiring diagrams as may be necessary.

### 3.3 CUTTING & PATCHING

- .1 Lay out and install work in advance of other Sections for all new work. Bear all costs resulting from failing to comply with this requirement.

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### MECHANICAL GENERAL REQUIREMENTS

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- .2 Core drill holes up to 200 mm diameter (150 mm pipe) in concrete walls and floors for piping where not previously sleeved. Do not use mechanical hammers or drills without prior approval in writing. Neatly patch holes to approval and where located in exterior walls above grade, make watertight. Make holes in walls below grade with due provision for pipe movement (min. 50 mm clear all around), fill with 50 mm thick fiberglass blanket insulation and seal watertight with mastic.
- .3 Layout cutting and patching for approval before starting and obtain approval of finished work.
- .4 See 3.6 Supports, 3.8 Hangers and 3.9 Sleeves, and co-ordinate this work to other Sections to prevent unnecessary cutting and patching.

### 3.4 EXCAVATING

- .1 Perform necessary excavating for work of this Division. Ensure bottoms of trenches are excavated so that full length of each pipe will be supported on solid bed of undisturbed earth. Build approved concrete pad, solid block or concrete piers properly reinforced under piping below grade where solid undisturbed earth bed is not obtainable to meet Plumbing Code.
- .2 Remove excavated materials not used as backfill from site unless otherwise directed.
- .3 See Soil Test Report re existing soil conditions. Support all piping on approved earth or other foundation or hangers. Earth support must be minimum 90% density Modified Proctor (ASTM #D-1527) compaction and proven such conditions exist. Include for necessary soil tests to verify earth foundation will support drains as required at approximately 2400 mm centres. Provide supports to meeting Plumbing Code, Section 51 including piers where earth foundation or hangers are not acceptable to Architect or authority having jurisdiction.
- .4 Where permitted by authority having jurisdiction where pipe invert is less than 900 mm below floor elevation steel clevis hangers, steel rods and continuous steel supports from floors at half normal spacing may be used. Paint all buried metal hanger work with 2 coats of Bakelite #110-14.
- .5 Provide necessary shoring and support for trenching. Do all work in conformity to Ontario Trench Excavator's Protection Act and Occupational Health & Safety Act, each as amended to date. Trench widths shall be kept to minimum dimension as directed & approved.
- .6 Perform necessary pumping to maintain excavations free of water for work of this Division until backfill is completed.

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## MECHANICAL GENERAL REQUIREMENTS

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- .7 Provide 100 mm bed of 20 mm crusher run limestone compacted to 98% Modified Proctor under all piping not laid in sandy ground or other approved bedding. For copper and plastic piping, bedding shall be clean sand.

### 3.5 BACKFILLING

- .1 Backfill at least first 150 mm above top of piping with clean coarse sand hand placed in 75 mm layers and compacted to 98% density Proctor Modified (ASTM #D1527). Note conditions and Details and conform thereto.
- .2 Backfill inside building with M.T.C. granular 'B' or clean coarse sand in 150 mm layers mechanically compacted to give minimum of 98% density Modified Proctor (ASTM #D-1527 STD) compaction.
- .3 For Landscape Areas: Backfill outside building with approved clean earth in 300 mm layers watered and compacted to 98% Modified Proctor. Do not use clay, rock, frozen earth, rubbish or other unapproved materials. Remove same from site and bring in approved earth or sand for use in this event.
- .4 Backfill under all existing, new and future concreted, paved or gravelled areas with M.T.C granular 'B' placed in 150 mm layers and compacted to 98% Modified Proctor Compaction to level of sub-base of paving or gravel.

### 3.6 SUPPORTS

- .1 Supply and install supports, stands and platforms necessary for proper installation of equipment and components, of steel or wood as may be required and as approved or elsewhere shown or specified. Supply and install necessary anchor bolts and other fastenings. Secure work to concrete with Phillips "Red Head" concrete anchors.
- .2 Concrete housekeeping bases and all required concrete work will be provided by this Section.

### 3.7 FLASHINGS

- .1 Where ducts pass through roof, Another Section will provide suitable curb and flashing. Supply and install approved counterflashing of same material as flashing.
- .2 Where equipment is roof mounted, this Section will provide suitable approved curbs and bases properly flashed and sealed to roof unless otherwise noted.
- .3 Where plumbing vents and stacks, boiler stacks, or other pipes pass through roof, provide Thaler series MEF flashings complete with necessary insulation.

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MECHANICAL GENERAL REQUIREMENTS

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**3.8 HANGERS**

- .1 Supply and install hangers to support pipes and ducts. Adjust hangers so that pipes and ducts will be true in respect of alignment and grade. Obtain approval of methods of hanging to building before proceeding. Ensure that load on building structure does not exceed maximum mechanical loading per square foot as directed by Consultant. Take special care to avoid introduction of undue reaction forces into structure of building.
- .2 Where structural bearings do not exist, supply and install auxiliary angle or channel iron of sufficient size from other structural bearings to support hangers or equipment. Do not hang from steel decking
- .3 Do not use wire, chain, strap or extension bar hangers under any circumstances.
- .4 Do NOT use percussion type fastenings of any kind without prior approval in writing.
- .5 Install all work supported from hangers or supports in a manner to ensure that building construction is not weakened or over-stressed, that pipes and ducts are secure, vibration free, free to expand and contract and properly graded, and that vertical adjustment of horizontal pipes and ducts is possible after erection.
- .6 Support all hangers directly from building structure only. Do not support pipes, ducts or equipment from other pipes, ducts or equipment.
- .7 Support horizontal piping with clevis hangers as follows:  
  
Up to 32 mm size - 1800 mm maximum spacing  
38 to 75 mm size - 3000 mm maximum spacing  
88 mm size and larger - 4300 mm maximum spacing
- .8 Support plumbing piping in accordance with more stringent requirements of Plumbing Code or these specifications.
- .9 Where hangers are grouped, locate spacing by smallest size pipe. Do not use trapeze type hangers unless specifically shown. Where trapeze hangers are used, fit insulated piping with insulation shields taped to insulation.
- .10 Support through vertical piping with riser clamps at each floor level or maximum of 3 metres whichever is shorter. Secure small vertical piping with long ring stays.
- .11 On copper piping, supply and install approved separation to ensure no contact between copper and ferrous hanger or other work. Supply and install barrier to prevent copper pipe being in contact with ferrous or cinder materials.

### MECHANICAL GENERAL REQUIREMENTS

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- .12 Support hangers with threaded mild steel hangers rods sized in accordance with hanger manufacturer's tables. Affix to building structure by coach screw threads into wood construction, inserts into concrete, by beam clamps on to structural steel work, or by bolts or welding. Where inserts are incorrectly placed, Phillips "Red Head" concrete anchors may be used.
- .13 Support piping on walls with offset wall hooks fastened to wall with toggle bolts or Phillips "Red Head" concrete anchors.
- .14 Hangers shall be arranged so as to load structural steel in a concentric manner. Loads shall be imparted either on joist panel points or within 150 mm of panel joint.
- .15 Rawl Drill Anchors and Rawlys may be used to attach to existing structure sized to suit load with 5 to 1 safety factor.
- .16 Support all hangers directly from building structure only. Do not support pipes, ducts or other equipment from other pipes, ducts, equipment, suspended ceilings or their suspension systems.
- .17 Hang new piping for at least 2 support points from isolated equipment with Burgess-Vibro Acoustics or equal 'SH' isolators with steel spring having 25 mm minimum static deflection and series connected elastomer element having static deflection of 6 mm underload.
- .18 Where structural steel is to be fireproofed, hangers and attachments MUST be placed BEFORE fireproofing is installed. Cost of any repair will be charged to Section responsible for same.

### 3.9 SLEEVES

- .1 Where pipes pass through masonry walls, supply and install suitable 1.2 mm (18 gauge) galvanized steel sleeves. Size sleeves on insulated pipes to permit insulation to continue through sleeves. Sleeve ductwork similarly.
- .2 Where pipes pass through concrete or frame construction, supply and install 1.2 mm (18 gauge) galvanized iron sleeves. Provide copper sleeves on copper pipe.
- .3 Seal spaces between unburied pipes and ducts through "required" fire separations" with U.L.C. listed (Guide 40U19) fire stopping including pipe insulation. Fire stopping shall comply with O.B.C., be approved by local Building Department and installed as per listing Card, Firestopping shall have approved FH (hose stream) rating.

## MECHANICAL GENERAL REQUIREMENTS

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- .4 Seal all holes and openings through floors water tight. In rooms with mechanical equipment, sleeves through floors shall be welded water stop flange steel pipe sleeves poured in place and extending at least 100 mm above floor or pipes shall have Corrosion Services Co. Ltd. "Link Seals" installed to manufacturers directions. Where ducts pass through floors, provide 100 mm high by 100 mm concrete curb around ducts sealed to floor. Locate openings in field to be snug around ducts and be responsible for correct size and location.
- .5 Sleeves on buried piping shall be 50 mm larger all round than pipe and be filled with 50 mm thick fiberglass blanket insulation and sealed with mastic.

### 3.10 LEVELS & DIMENSIONS

- .1 General Contractor, on request, will supply this Division with necessary levels and dimensions which are required to relate work of the Division to other Sections. Maintain all lines and levels so given and relate this work to work of other Sections.

### 3.11 PAINTING

- .1 Supply all equipment and materials fabricated from iron or steel (except ductwork materials) prime and finish painted at factory before shipment. If damaged, touch up with suitable primer and finish paint. All auxiliary support steel supplied by this Division shall be prime painted with one coat of red oxide primer and finish paint.
- .2 All metal parts, miscellaneous metal items and work installed exterior to building (except aluminum) must be degreased and prime and finish paint unless otherwise noted.
- .3 Painting of bare piping, ductwork, insulation and finish painting of equipment will be done by this Section unless otherwise noted.
- .4 Consult with Architect about colour of exterior equipment and materials.

### 3.12 EQUIPMENT MARKERS & NAMEPLATES

- .1 Attach to each item of equipment (including electric motors), proper manufacturer's nameplate showing size, model number, serial number, and all information usually provided including voltage, cycle, phase and horsepower of motors and name and address of unit manufacturer.
- .2 Ensure stamped, etched or engraved lettering on plates is legible. Nameplates shall not be painted over and where apparatus is insulated, provide adequate openings in insulation for viewing purposes.



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## MECHANICAL GENERAL REQUIREMENTS

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- .3 Provide on each item of equipment suitable nameplate. Before nameplates are made, submit sample and list of names for approval. Make nameplates of 1.6 mm (1/16 ") thick weather resistant rigid laminated plastic with engraved letters on black background. Secure nameplates with drive screws. Make letters on starters, timers and small items at least 5 mm (3/16") high and at least 10 mm (3/8") high on larger units such as fans. Generally, unit nameplates shall conform to those noted in their Schedules.

### 3.13 PIPE IDENTIFICATION

- .1 Identify exposed service piping at 6 metre intervals and at each valve behind access panel with service name and flow direction marked on piping using Mystic labels, Westline or Brady "Perma-Code" labels, each applied with #3M clear adhesive. Replace loose or lost labels at end of one year guarantee period without charge. Painted stencil markings are acceptable. Provide similar direction of flow arrows at each label.

### 3.14 CLEANUP

- .1 On completion, remove from premises surplus materials and debris resulting from work of this Division. Keep work areas clean and in a workmanlike manner at all times to approval.
- .2 Fill in, compact and level off exterior excavations after final settlement of backfill to approval.

### 3.15 VALVE TAGS & CHART

- .1 Provide on each valve, 25 mm diameter or larger brass tag with punched and embossed numbers. Valves immediately adjacent to plumbing fixtures or radiation need not be tagged.
- .2 Provide where later directed, a neat, glass fronted, framed chart stating number, location, service and function of each valve and lines controlled. Mount 1800 mm above floor to bottom.
- .3 Frame each pressure vessel, H.W. tank and Boiler Certificate under glass and hang where directed in room where unit is located. Mount 1800 mm above floor to bottom.

## MECHANICAL GENERAL REQUIREMENTS

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- .4 Identify exposed service piping at 6 m intervals and at each valve behind access panel with service name marked on piping using "Mystic" labels (H.A. Scarlett Industries), Westline or Brady "Perma-Code" labels, each applied with #3M clear adhesive. Replace loose or lost labels at end of one year guarantee period without charge. Painted stencil markings are acceptable. Provide direction of flow arrow at each service label.

### 3.16 PIPE AND VALVE IDENTIFICATION TABLE

.1	<u>Pipe Marker Legend</u>	<u>Valve Tag Legend</u>	<u>Primary Colour</u>
	City Water	CI.W.	Green
	Cold Water	C.W.	Green
	Drinking Water Return	D.W.R.	Green
	Dom. Hot Water Supply	D.H.W.S.	Green
	Dom. Hot Water Return	D.H.W.R.	Green
	Make-Up Water	M.U.A.	Yellow
	Storm Sewer	S.S.	Green
	Sanitary Sewer	SAN.S.	Green
	Natural Gas	N.G.	Yellow
	Vent (plumbing)	V.P.	Green
	Vent	V.	Yellow

### 3.17 COLD WEATHER WORK

- .1 Wherever work is performed in surrounding air temperatures below 4.0°C special approved precautions shall be taken to prevent damage to mortar, concrete or materials. All such materials used at such times shall be heated. Right is reserved to suspend work at any time should climatic conditions be deemed unsuitable for proper execution of work.

### 3.18 FLOOR & WALL PLATES

- .1 Provide one piece nickel-plated flanges of stamped brass in finished areas at points where exposed uncovered pipes pass through walls, floors or ceilings. Secure plates at ceiling with integral brass set screw.
- .2 Split plates will not be accepted.

### 3.19 WORK SCHEDULE

- .1 Refer to Division 1 General Requirements, for details of work scheduling and comply with same.

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**MECHANICAL GENERAL REQUIREMENTS**

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**3.20 SHOP DRAWINGS**

- .1 Submit for review in accordance with Division 1, within 30 days of Contract award, 8 copies of Shop Drawings and Room Equipment Schedules covering material to be supplied.
- .2 Make submittals of more than two pages in individual booklet form for easy processing. Failure to comply may cause undue delay in approvals. Each shop drawing must be certified correct by submitting trade before submission.
- .3 Review of Shop Drawings is for sole purpose of ascertaining conformance with general design concept. This review shall not mean that Engineer approves detail design inherent in Shop Drawings, responsibility for which shall remain with Contractor and such review shall not relieve Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of Contract Documents. Contractor is responsible for dimensions to be confirmed and correlated at site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of work of all trades.

**3.21 EXAMINE SITE & CONDITIONS**

- .1 Examine site and local conditions. Examine carefully all Drawings and complete Specifications to ensure that work can be satisfactorily carried out as shown. Before commencing work, examine the work of other Sections and report at once any defect or interference affecting the work, its completion or warranty. No allowance will be made later for any expense incurred through failure to make these examinations or to report any such discrepancies in writing.

**3.22 HIGH EFFICIENCY MOTORS**

- .1 Provide high efficiency motors in accordance with CAN/CSA-C390-1998. This applies to all three phase motors 1 HP and above.
- .2 Mechanical Division shall make the application for same when all the actual motor horsepower are finalized.
- .3 All motors shall bear nameplates listing nominal full load efficiency.

END OF SECTION

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INSULATION

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CONTENTS

SUBSECTION

TITLE

PART 1 - GENERAL

- |     |                      |
|-----|----------------------|
| 1.1 | Related Instructions |
| 1.2 | Work Included        |
| 1.3 | Submittals           |

PART 2 - PRODUCTS

- |     |                               |
|-----|-------------------------------|
| 2.1 | Materials                     |
| 2.2 | Piping & Equipment Insulation |
| 2.3 | Duct Insulation               |

PART 3 - EXECUTION

- |     |                           |
|-----|---------------------------|
| 3.1 | Testing                   |
| 3.2 | Installation Instructions |
| 3.3 | Field Quality Control     |

## INSULATION

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### PART 1 - GENERAL

#### **1.1 RELATED INSTRUCTIONS**

- .1 Comply with requirements of Section 21 05 01, Mechanical General Requirements.

#### **1.2 WORK INCLUDED**

- .1 Work under this contract shall include but is not limited to the following.
- .2 Supply and install insulation for following piping and duct systems:
  - .1 Domestic water piping.
  - .2 Interior exhaust air ducts from backdraft dampers to louvres or outlets.
  - .3 Miscellaneous piping and ducts noted on Drawings or in specifications.
  - .4 Sanitary soil and waste piping from W.C.'s, urinals and drinking fountains.
  - .5 Storm & sanitary drains.
  - .6 Miscellaneous insulation as specified.
  - .7 Condensate drain pipes.
  - .8 All exposed PE piping.
  - .9 All headers.
  - .10 Fresh air and exhaust ducts.
  - .11 Heat pumps unburied piping.

#### **1.3 SUBMITTALS**

- .1 Submit detailed list of material for each service stating manufacture, 'K' value, density, finish, flame spread and smoke ratings, permability, materials, finishes, cements and adhesives.

### PART 2 - PRODUCTS

#### **2.1 MATERIALS**

- .1 Provide insulation of equipment, piping and ductwork as described or noted. Insulation, jackets and adhesives shall be incombustible, in compliance with Ontario Building Code; installed to manufacturer's standards, and to approval. Wheat pastes shall NOT be used. Products containing asbestos shall not be used. Make suitable approved openings in insulation for inspection outlets and equipment nameplates.
- .2 All insulation products used shall be fully tested and approved as fire retardent by Underwriters Laboratories of Canada Limited.

## INSULATION

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- .3 Materials shall be of Canadian manufacture where available, of best quality of their respective kinds and of uniform pattern throughout.
- .4 All insulating materials shall be fire retardent. Adhesives shall be waterproof and incombustible flame resistant. Combustible wrappings or vapour barriers used in conjunction with thermal insulating materials shall be treated to reduce their combustibility so that flame spread classification of entire assembly shall not exceed 25 and smoke developed number shall not exceed 50. Submit report from an approved testing laboratory confirming foregoing ratings.
- .5 Wheat pastes shall not be used.
- .6 Canvas covering shall be close weave fibre fire retarding canvas of weights specified, 4.0 oz (135.6 g/m<sup>2</sup>) where concealed and at least 6.0 oz (203.4 g/m<sup>2</sup>) where exposed to view. All exposed insulation shall be covered with canvas.
- .7 Consultant reserves right to demand test samples to composite insulation systems for fire hazard test rating.
- .8 Where wire is specified to secure insulation, it shall be stainless steel wire, 1.3 mm gauge, dead soft annealed type.

## 2.2 PIPING & EQUIPMENT INSULATION

- .1 Unburied domestic cold water piping and unburied heat pumps piping: Heavy density glass fibre preformed pipe insulation with maximum of 0.033 conductivity at 10°C mean with factory applied vinyl foil kraft laminated glass fibre reinforced fire resistive vapour barrier jacket with not more than 1.15 perm rating (ASJ) with sealed lapped joints. Insulate heat pump units condensate lines similarly. Cover insulation on heat pump condensate line with the specified canvas. Use 25 mm thickness on piping up to 50 mm size, and 38 mm thickness on piping 63 mm and above in conditioned area. In non conditional areas use 25 mm thickness upto 25 mm size, 38 mm thickness for 25 mm to 50 mm pipe size 75 mm thickness on pipes larger than 63 mm size. For heat pumps piping use 38 mm for pipes up to 50 mm in size.
- .2 Unburied domestic recirculation and hot water piping: heavy density glass fibre preformed pipe insulation with maximum 0.043 conductivity at 93°C mean with factory applied fire resistive vapour barrier jacket of not more than 1.15 perm rating. Use 25 mm thickness on piping up to 50 mm size, and 38 mm thickness on piping 63 mm and above in conditioned area. In non conditional areas use 25 mm thickness upto 25 mm size, 38 mm thickness for 25 mm to 50 mm pipe size 75 mm thickness on pipes larger than 63 mm size.

## INSULATION

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- .3 Unburied Rain Water Leaders and storm drains both exposed and concealed: insulate with 1" thick fiberglass pipe covering with factory applied aluminum fire resistant vapour barrier and sealed lapped joints. Insulate underside of roof hoppers.
- .4 Exposed horizontal runs and vertical drops of sanitary drains: insulate as for storm drains above. Also insulate horizontal wastes from urinals, toilets and drinking fountains concealed in ceiling spaces to vertical stack.
- .5 Valves and fittings: 25 mm glass fibre blanket conforming to CGSB #51-BF11 compressed to same thickness as adjoining insulation and secured with jute twine. Over this apply smooth coat of insulating cement and recover with 4 oz. (135.6 g/m<sup>2</sup>) canvas. On cold water piping wrap blanket with foil faced friction tape overlapped to form vapour barrier before applying insulation cement. Seal all vapour barriers.
- .6 All headers shall be insulated similar to low and high temp. pipe in .3 above.
- .7 Insulate refrigerant piping with 19 mm Armaflex II or Acwil "Therma-Cel" flexible foamed elastomeric insulation with fittings and valves insulated to match. Weatherproof exterior insulation with two coats of Armaflex White Finish thoroughly sealed. Interior insulation shall be left ready for painting by another Section
- .8 Work which is inaccessible for application of insulation after installation shall be insulated and finished before being placed in position.
- .9 Canvas covering shall be applied to all exposed insulation.
- .10 On all pipe insulation in the Mechanical Room apply smooth coat of insulating cement and recover with 6 oz (203.4 g/m<sup>2</sup>) canvas jacket neatly parted on with fireproof adhesive. Then cover with PVC jacket.

### 2.3 DUCT INSULATION

- .1 Seal duct insulation with mastic at all joints and pins. Tape all joints with approved self-adhesive foil faced glass fibre reinforced 50 mm wide vapour barrier tape. Where ducts are sound lined or fire proofed thermal insulation is not required but shall overlap liner at least 150 mm except where noted.
- .2 Exposed to weather ductwork: 50 mm (two layers of 25 mm) thick glass fibre rigid insulating board with reinforced foil faced flame resistant kraft vapour barrier. Insulation shall have 0.03 perm rating minimum. Encase insulation in aluminum cladding.

## INSULATION

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- .3 Externally insulate 1800 mm of exhaust ducts upstream outlet with 25 mm thick , 72 kg/m<sup>3</sup> density glass fibreboard with foil vapour barrier pinned on with joints glass cloth taped and sealed with incombustible adhesive. Insulate all above ducts whether or not sound lined.
- .4 Sizing and painting of insulation will be done by another Section unless otherwise noted.

### PART 3 - EXECUTION

#### **3.1 TESTING**

- .1 Insulation shall not be installed until piping and ductwork has been tested to Consultant's satisfaction. Repair to or replacement of insulation is required if installed prior to such testing approvals being given.

#### **3.2 INSTALLATION INSTRUCTIONS**

- .1 General
  - .1 Pipe and fittings shall be dry, free of dirt, scale, rust, oil and grease before insulation is applied. Rustproof ferrous materials where necessary as directed by Consultant using approved materials and methods.
  - .2 All insulation material and adhesives shall be installed in strict compliance with latest editions of manufacturer's recommendations and shall present neat workmanlike appearance upon completion.
  - .3 Under no circumstances shall ambient temperature in space be less than 50°F during application of any insulation or finishing. Where higher temperature is required by manufacturer's recommendations, this higher temperature requirement shall be complied with.
  - .4 Work shall be performed only by tradesmen experienced in insulation work.
  - .5 Recover all interior insulation exposed to view with 6 oz. (203.4 g/m<sup>2</sup>) canvas duck pasted on over insulation with approved flame resistant adhesive to form smooth even surface. Exposed insulation in Utility Room shall be covered with PVC jacket. Colour to be determined by Architect on site.
  - .6 Work which is inaccessible for application of insulation after installation shall be insulated and finished before being placed in position.
  - .7 Provide suitable approved openings in insulation for inspection outlets, equipment nameplates and operating devices.



## INSULATION

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- .8 Install all insulation in first class manner with smooth and even surfaces. Outline of round insulation shall be true circular and concentric shape. Outline of fitting insulation shall be shaped to blend with adjacent covering. Do not use scrap pieces of insulation where full length section will fit.
  - .9 Joints in insulation shall be made by cementing pieces together and finishing so that there are no cracks or gaps.
  - .10 Take care that insulation over flexible connections in piping does not unduly increase lateral or longitudinal stiffness of connections.
  - .11 Sectional insulation furred into spaces or concealed in walls, hung ceilings and pipe spaces shall not have extra jacket. However, canvas covers supplied as standard on insulation used in such locations, shall remain with overlap pasted down.
  - .12 Keep insulation clear of instruments, controls, components, access doors and operating devices so that it will not hinder or interfere with removal, setting, reading of or access to same. Verify with Consultant as to whether such items are located properly before applying any insulation, otherwise be responsible for all retouching that may be required.
  - .13 Repair and reseal all breaks, cracks and perforations in vapour barriers. Seal all weld pin penetrations of vapour barrier with 100 mm x 100 mm patch of aluminum foil tape.
  - .14 Size all insulation exposed to view and leave ready for painting by another Section unless otherwise noted.
  - .15 Insulation shall continue through sleeves and openings except at "Required Fire Separations" where sleeves and openings shall be "Fire Stopped". See 21 05 01 - Sleeves. Insulation shall be butted tight to fire stopping and vapour sealed.
- .2 Pipework
- .1 Pipe insulation shall be carried uninterrupted through pipe sleeves except where otherwise noted or required by Ontario Building Code or local authority. Where space will not permit application of sectional insulation on pipes in sleeves, pack sleeves with approved fire stop material.
  - .2 Insulation shall be continuous on piping systems. Insulate valves and joints to same thickness of insulation as specified for pipe. Seal vapour barriers to approval where pipes pass through sleeves after sleeves are packed.
  - .3 Do not insulate unions but terminate pipe insulation neatly with cement at each end of unions except on cold water piping where unions shall be insulated.
  - .4 Carry insulation through hanger clevises and where noted use insulation protection saddles between clevis and insulation.
  - .5 Insulate water piping in cupboards and closets as for exposed piping.

## INSULATION

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- .6 Hangers directly supporting cold water piping shall be insulated and vapour sealed as part of adjoining pipe.
  - .7 Buried cold water piping need not be insulated.
- .3 **Ductwork**
- .1 Co-operate with sheet metal installer to ensure correct installation of insulation plugs for pitot tube test openings in ductwork.
  - .2 Duct insulation shall be carried uninterrupted through sleeves except where otherwise noted or required by Ontario Building Code or local authority. Where space will not permit application of sectional insulation on ducts in sleeves, pack sleeves with approved fire stop material. See 21 05 01. Seal vapour barriers to approval where ducts pass through sleeves after sleeves are packed.
  - .3 Where duct insulation is secured by wire, it shall not be drawn so tightly as to unduly compress insulation. Where Consultant judges insulation has been compressed too much under wire or twine or at corners, it shall be removed and reapplied.
  - .4 Sagging of duct insulation will not be accepted. Remove and reapply.
  - .5 Do not break continuity of insulation vapour barrier by hanger or rods. Remove hangers temporarily to facilitate installation of vapour barrier where required.
  - .6 Supply and install cap strips to cover turned out legs of ductwork reinforcing and supporting members.
  - .7 Seal duct insulation at all joints, pins and openings. Tape joints with approved self-adhesive foil faced 50 mm wide vapour barrier tape.
  - .8 Insulate each duct access door to maintain insulation and vapour barrier rating when access door is closed.

### **3.3 FIELD QUALITY CONTROL**

- .1 Keep insulation materials dry while in shipment and on site.
- .2 Treat all insulation and finishes so that maximum Flame Spread Rating is 25 or lower and Smoke Index Rating is 50 or lower.
- .3 Protect insulation passing through floors, walls and similar barriers with a metal sleeve large enough to accommodate full thickness of insulation.

END OF SECTION

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FIRE PROTECTION

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
-------------------	--------------

PART 1 - GENERAL

1.1	Related Instructions
1.2	Qualifications
1.3	Submittals
1.4	Tender
1.5	Sprinkler System Design
1.6	Drawings
1.7	Co-operation

PART 2 - PRODUCTS

2.1	Materials
2.2	Sprinkler Heads
2.3	Pipe & Fittings
2.4	Valves
2.5	Alarms
2.6	Hangers
2.7	Excess Pressure Pump
2.8	Pressure Gauges
2.9	Fire Department Connection
2.10	Backflow Preventer
2.11	Electric Pipe Tracing

...Continued

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FIRE PROTECTION

---

CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
<u>PART 3 - EXECUTION</u>	
3.1	Piping Tests
3.2	Joints
3.3	Sprinkler Heads
3.4	Pipe & Fittings
3.5	Alarms
3.6	Hangers
3.7	Excess Pressure Pump
3.8	Water Service & Exterior Piping
3.9	Pressure Gauges
3.10	Fire Department Connection
3.11	Valve Tags & Charts
3.12	Instructions to Operator
3.13	Electric Pipe Tracing
3.14	Final Inspections
3.15	Special Instructions

## FIRE PROTECTION

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### PART 1 - GENERAL

#### **1.1 RELATED INSTRUCTIONS**

- .1 Comply with requirements of Section 21 05 01 – Mechanical General Requirements.
- .2 Required Fire Protection for the Project is a Design Built System. Criteria described in specification shall be used as a minimum requirement for the Project.

#### **1.2 QUALIFICATIONS**

- .1 Work of this Section shall be done by a duly licensed and qualified Fire Protection Sprinkler Contractor and a member of Canadian Automatic Sprinkler Association regularly engaged in installation of automatic fire sprinkler systems and other fire protection equipment.
- .2 Subcontractor for this Section must have at least 5 years experience in type and class of work shown and be able to give resume of at least 3 similar projects completed within previous 12 months.

#### **1.3 SUBMITTALS**

- .1 Submit Shop Drawings for following:
  - .1 Sprinkler heads
  - .2 Monitor switches
  - .3 Flow alarm switches
  - .4 Pressure switches
  - .5 Alarm/check valves and accessories
  - .6 Valves
  - .7 Pressure gauges and cocks

#### **1.4 TENDER**

- .1 This Section shall be tendered as a separate section to General Contractor and not form part of work of Section 220500.

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**FIRE PROTECTION**

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**1.5            SPRINKLER SYSTEM DESIGN**

- .1      Standard or fixed temperature system of automatic spray sprinklers throughout based upon requirements of local Fire Department and Owners Insurance Company in accordance with latest requirements of National Fire Protection Association (N.F.P.A.) Standard #13 and Ontario Building Code based on "Ordinary Hazard", except in Offices and similar occupancy can be light hazard if approved by Fire Department.
- .2      System shall be "Constant Pressure Wet Pipe" with alarm valves, shut-off valves and accessories. Provide "Dry System" for areas subject to freeze.
- .3      Sprinkler system shall be for hazard as required. Sizing shall be hydraulic based using areas of application and density both as outlined in applicable Fire Protection standards and approved by Underwriter and local fire authority to give protection to entire building.
- .4      Arrange and pay for suitable flow test witnessed by Insurance Underwriter and local Fire Department as basis of design. Submit copies of test to Underwriter, local Fire Department and Consultant.

**1.6            DRAWINGS**

- .1      Accompanying drawings indicate areas to be sprinkler protected and generally systems to be installed and is not limited to exact number of heads required to give necessary protection to approval of authorities having jurisdiction. Prepare engineered shop drawings and submit for Consultant and Engineers approval at least 2 copies and 1 reproducible copy of minimum 1:100 scale drawings approved by Underwriter and local Fire and Building Departments showing actual system being installed including required hydraulic calculations. Pay for approvals and all fees.
- .2      Drawings shall be coordinated with Architectural Detail Drawings showing bulk heads, drop ceilings, interferences and all trades concerned and shall show sleeves, openings, passage of piping through building structure, type and location of heads and similar information. Piping shall not pass through ducts nor interfere with service spaces for equipment, coils, controls or operating devices.
- .3      After approval, revise drawings as necessary and supply 10 sets and a reproduceable for distribution to trades concerned through Consultants.

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**FIRE PROTECTION**

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**1.7 CO-OPERATION**

- .1 Co-operate with all other Sections so that Sprinkler System may be installed so that it will not conflict with architectural, electrical, structural or other mechanical work.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- .1 Materials shall be new, of Canadian manufacture where available; and of best quality of their respective kinds and of uniform pattern throughout. See 210501.
- .2 Material to include flanged alarm/check valves, necessary shut-off valves, check valves, draw-off connections, inspectors test valves and any necessary auxiliary connections as shown or required by Ontario Building Code, local Fire Department and Insurance Underwriters' Inspector.

**2.2 SPRINKLER HEADS**

- .1 Sprinkler Heads shall be approved equal bulb type sprinkler heads approved by ULI, ULC or FM.
- .2 See Subsection 3.3 for detailed for type sprinkler heads required.

**2.3 PIPE & FITTINGS**

- .1 Unburied mains and sprinkler piping: standard black steel Schedule #40 (ASTM #A53) with black cast iron 1207 kPa WWP screwed or flanged fittings, U.L.C. approved. Victaulic or Couplex couplings and fittings with Butyl gaskets conforming to CSA #B242 may be used where approved by Insurance Underwriter and local authority.

**2.4 VALVES**

- .1 Valves shall be gate valve pattern of Crane or approved equal manufacture all-brass up to and including 50 mm size. Larger sizes shall be iron body brass trimmed and of flanged O.S. & Y. type. Valves shall be 1380 kPa water pattern, U.L. or F.M. approved.
- .2 Check valves shall be of same materials and pressures as specified for gate valves above, of swing check type and have regrinding feature, U.L. or F.M. approved.

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## FIRE PROTECTION

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- .3 Underwriters Approved butterfly valves and wafer check valves may be used in lieu of gate and swing check valves. Such valves shall be lug body style rated for 1207 kPa WWP suitable for dead end service with one flange disconnected.

### 2.5 ALARMS

- .1 Pressure switches shall be ULC approved, 24 volt pressure switch.
- .2 Water Flow Alarm Switches shall be ULC approved DPST 24 volt, each with adjustable (60 second minimum) retard.
- .3 Monitor switches shall be Potter Electric Signal & Mfg. Co. or approved equal, ULC approved monitor switch (N.O. contact) set to initiate alarm if valve is closed more than 15%.
- .4 Alarm system pressure switches shall be ULC approved, 24 volt D.P. pressure switch to signal alarm system on pressure below 550 kPa (80 psig).

### 2.6 HANGERS

- .1 All hangers shall be U.L. or F.M. approved and comply with U.S. Federal Specification #WW-H-171c and UL #203.

### 2.7 EXCESS PRESSURE PUMP

- .1 Excess Pressure Pump shall be ULC approved with 249 Watts 60/1/115 volt motor with H/O/A starter.

### 2.8 PRESSURE GAUGES

- .1 Pressure gauges shall be ULC approved, range 0 to 1050 kPa (0-150 psig) Metric or dual scale with at least 114 mm dial face and complete with 6.4 brass petcock and snubber.

### 2.9 FIRE DEPARTMENT CONNECTION

- .1 Provide 150 mm flush type Fire Department connection with two 63 mm connections c/w chains, caps. National Fire Model #229 or equal.

### 2.10 BACKFLOW PREVENTER

- .1 Provide backflow preventer Model Watts #757DCDA or Wilkins c/w shut-off valves, bypass meter and strainer to incoming water service.



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**FIRE PROTECTION**

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**2.10 ELECTRIC PIPE TRACING**

- .1 ULC listed with digital Heat Trace Controller for monitoring power interruption and on –off temperature adjustments with required number of sensors. Controller shall include ground fault protection and shall monitor ground fault, power loss, sensor failure and low temperature.
- .2 Provide all required accessories including Splice Kit, Power Connection Kit, End Seals, Label and Tee Kit as supplied by Raychem or approved equal.
- .3 Electric pipe tracing shall be rated for 208V/1 Phase
- .4 Acceptable manufacturer:
  - .1 Raychem 8XL-2 trace with Digi Trace Controller C910 and required number of RTD-1 OCS sensors.

**PART 3 - EXECUTION**

**3.1 PIPING TESTS**

- .1 In addition to any tests required by local authorities, test new piping in presence of Consultant as hereinafter described.
- .2 Notify Consultant in writing at least 48 hours prior to start of tests. Failure to do so may require test to be redone. Test buried work before backfill is placed.
- .3 Fill each piping system with cold water and pressure test at 1400 kPa minimum for not less than four hours without decrease in pressure. Protect equipment and parts not capable of withstanding test pressure during test.
- .4 Test on buried piping may be made after piping has been partially backfilled to hold in position but all joints shall be exposed to inspection.
- .5 Make leaks tight while systems are still under test. If this is impossible, remove and refit defective parts. Caulking of threaded joints or welds will not be permitted.
- .6 After leaks have been repaired, repeat tests as often as necessary to ensure tightness of system.

**3.2 JOINTS**

- .1 Joints in buried pipe shall be of mechanical type as recommended by pipe manufacturer, ULI or ULC approved and to local regulations.

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FIRE PROTECTION

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- .2 Make joints in threaded pipe with lead free joint compound. Use of lampwick or hemp will not be permitted.

### **3.3 SPRINKLER HEADS**

- .1 Provide sprinkler heads where shown and required. Exact locations of heads shall be coordinated with lights, diffusers, etc. to approval. Supply Shop Drawings and sample of each type of head proposed for use before starting work.
- .2 Areas which contain finished ceilings shall have concealed piping with brushed chrome fully recessed pendent sprinkler heads with coverplate to match existing.
- .3 Areas without finished ceilings shall have exposed piping and standard pendent or upright brass sprinkler heads.
- .4 Where required, provide sidewall sprinkler heads to match adjacent heads complete with escutcheons at wall.
- .5 Provide high temperature heads at heaters to conform to N.F.P.A. #13. Arrange for service access to concealed heads.
- .6 Wherever possible, sprinkler heads and piping shall not be installed where there is not sufficient room to service same.
- .7 System shall include one sprinkler cabinet suitably located with at least 12 spare sprinklers of each type and sprinkler wrench for emergency use.
- .8 Provide approved wire guard on each sprinkler head mounted less than 3.2 m above floor, in Storage Rooms, and in locations subject to damage in normal building usage.
- .9 Provide sprinkler protection under all ducts over 1100 mm width.
- .10 Locate sprinkler heads with respect to surface light fixtures and other obstructions maintain minimum clearance required by NFPA #13 to avoid any obstruction to spray pattern of sprinkler heads.
- .11 Areas subject to freeze shall be dry type, or with antifreeze solution and reduced pressure principal type backflow preventer.
- .12 Sprinkler heads in light hazard occupancy shall be quick response type.

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## FIRE PROTECTION

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- .13 Provide approved window sprinkler to next requirement of BMECC and CCMC evaluation to provide required 2 hour protection.
- .14 Provide dry pendent sprinklers at all entrance lobby.

### 3.4 PIPE & FITTINGS

- .1 Provide new pipe and fittings free from rust and scale of full weight, standard size and thickness, true and round with full cut threads. Cut pipes true with clean sharp pipe cutters. Ream and file ends of pipe and remove burrs from interior. Use reducing fittings instead of bushings wherever reductions in piping occur.
- .2 Where approved by Consultant and Local Authority and Underwriter, Schedule 10 pipe and factory fabricated welded assemblies using ANSI #B16.9 factory made fittings may be used.
- .3 Pipe drains for main sprinkler risers, alarm valves, equipment, and Fire Department connection to Funnel Drain/within 150 mm of floor/through exterior wall to spill on grade to approval.
- .4 Pipe Inspector's test valves to suitable approved drains. Coordinate with Plumbing Section. Outlets shall not be piped to exterior except on grade floor.

### 3.5 ALARMS

- .1 Provide on each alarm check/valve, a pressure switch to close alarm contacts on water flow.
- .2 Provide on fire mains where shown, Water Flow Alarm Switches.
- .3 Provide at least 3 m above grade, a water motor alarm gong complete with piping to each zone alarm/check valve. Pipe 32 mm drain pipe to Funnel Drain to approval.
- .4 Provide monitor switches on each shutoff valve, and post indicator valve set to initiate alarm if valve is closed more than 15%.
- .5 Provide above each alarm/check valve, a pressure switch to signal alarm system on pressure below 550 kPa (80 psig).
- .6 Electrical Division will extend wiring to fire alarm panel. To ensure co-ordination at Shop Drawing stage, provide short descriptive wording of sprinkler valves, switches, controls, etc. to suit Electrical Fire Alarm System.

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**FIRE PROTECTION**

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- .7 Supply list of shut-off valve numbers and flow switch numbers to Electrical Subcontractor for co-ordination. Each number shall indicate area served.
- .8 Provide all information to Electrical Contractor to ensure a satisfactory graphic panel as required by Electrical Specifications and OBC.

**3.6 HANGERS**

- .1 See 210501 and conform thereto, except that hanger spacing may conform to spacing requirements stated in NFPA #13. Branch mains and cross mains may be hung with Myatt #120, Hanger Supply Co. #300N, or equal ring hangers.

**3.7 EXCESS PRESSURE PUMP**

- .1 Provide on approved bracket, Excess Pressure pump piped into each zone/system complete with shut-off and check valves. Supply manual starter with thermal overload motor, H/O/A and pilot light for wiring by Electrical Division. See 15050, for motor and starter details. See Starter Schedule. Provide and wire pressure switch to operate pump.

**3.8 WATER SERVICE & EXTERIOR PIPING**

- .1 Connect 200 mm sprinkler service at 1500 mm face of building provided by Another Section and extend to Sprinkler System for the building. Comply to Region of Peel requirements.
- .2 Anchor each bend, tee, cap and branch with 15 mPa cast in place concrete to Utility Standards.

**3.9 PRESSURE GAUGES**

- .1 Install pressure gauges on outlet of alarm/check valve, and on main header showing incoming pressure.

**3.10 FIRE DEPARTMENT CONNECTION**

- .1 Connect Fire Department connection to sprinkler system with check valve and 19 mm automatic drip valve piped to funnel floor drain.

**3.11 VALVE TAGS & CHARTS**

- .1 Supply and attach to each valve, Underwriter approved sign of service.

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## FIRE PROTECTION

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- .2 Provide where directed beside alarm valve station, neat glass fronted framed chart stating location, service and function of each valve and lines controlled. See 210501, for further detail.
- .3 Provide at alarm/check valve, a hydraulic design placard showing design criteria as approved by Authority in accordance with NFPA #13, Article 7-1.2.

### **3.12 INSTRUCTIONS TO OPERATOR**

- .1 Instruct Building Operator in care, maintenance and operation of Sprinkler System and associated equipment. See 210501 for further detail.

### **3.13 ELECTRIC PIPE TRACING**

- .1 Provide electric pipe tracing to all pipes subject to freeze.
- .2 Provide 63mm thick fiber glass insulation with sealed tight joints to all pipes where electric pipe tracing is provided.
- .3 Apply appropriate labels over insulated pipes.
- .4 Provide control wiring from each Pipe Sensor and Ambient Sensor to respective Digi Trace Controller. Run all control wiring in 20 mm conduit. All control wiring shall be ELDEN Type 8771, 22 Ga., 3 conductor and drain shielded type. Division 26 will extend monitoring wiring from Digi Trace Controller to communicator panel.
- .5 Follow manufacturer direction for heat tracing sprinkler branches and sprigs. Upon completion of work manufacturer shall review & submit written confirmation stating system to work when ambient temperature reaches 45°F.

### **3.14 FINAL INSPECTIONS**

- .1 Arrange for completed installation to be inspected by Owners Insurance Underwriter and present to Consultant/Engineer 4 copies of Certificate or Letter of Approval stating entire installation meets with their requirements.
- .2 Arrange for similar inspection and letter of approval from local Fire Department and Building Department.

### **3.15 SPECIAL INSTRUCTIONS**

- .1 Provide 25 mm drain line with line size shut off valve downstream of each flow switch, pipe same to nearest funnel floor drain at approved location.

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FIRE PROTECTION

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- .2 Sprinkler contractor shall NOT install his piping and sprinkler heads with disregard to lights, skylights, building design, etc. Failure to comply will ensure he changes all such interfering piping at his own expense.
- .3 Properly locate all sprinkler line and sprinkler heads with regard to all other trades to prevent conflict.
- .4 Prior to installation, lay out all exposed lines for Architect's approval on site, before commencing of work and also concealed lines wherever conflict can occur.
- .5 Piping heads in skylights must be coordinated with mullions, lights, etc., and approved by Consultant before installing.

END OF SECTION

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PLUMBING & DRAINAGE

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
<u>PART 1 - GENERAL</u>	
1.1	Related Instructions
<u>PART 2 - PRODUCTS</u>	
2.1	Materials
2.2	Pipe & Fittings
2.3	Valves
2.4	Cleanouts
2.5	Water Hammer Arrestors
2.6	Floor Drains
2.7	Fixtures & Fittings
2.8	Hose Bibbs
2.9	Drain Valves
2.10	Backflow Preventer
2.11	Domestic Water Heaters
2.12	Fire Equipment
2.13	Water Meter
2.14	Electric Pipe Tracing
2.15	Oil Interceptor
2.16	Recirc Pump
2.17	Roof Drains/Roof Hopper

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PLUMBING & DRAINAGE

---

CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
<u>PART 3 - EXECUTION</u>	
3.1	Tests
3.2	Venting
3.3	Connections To Fixtures
3.4	Joints
3.5	Pipe & Fittings
3.6	Valves
3.7	Drips & Drains
3.8	Expansion Provisions
3.9	Cleanouts
3.10	Floor Drains
3.11	Pipe Grading
3.12	Fixtures & Fittings
3.13	Temporary Water
3.14	Hose Bibbs
3.15	Backflow Preventer
3.16	Domestic Water Heaters
3.17	Temporary Water
3.18	Water Service
3.19	Water Meter
3.20	Storm Drainage System
3.21	Sanitary System
3.22	Oil Interceptor
3.23	Recirc Pump
3.24	Roof Drains/Roof Hopper
3.25	Connections for Other Sections
3.26	Operate and Adjust Systems
3.27	Warranty



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PLUMBING & DRAINAGE

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**PART 1 - GENERAL**

**1.1 RELATED INSTRUCTIONS**

- .1 Comply with requirements of Section 21 05 01 – Mechanical General Requirements.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- .1 Materials shall be new, of Canadian manufacture and of best quality of their respective kinds and of uniform pattern throughout.
- .2 All pipe fittings, valves, expansion joints, strainers, measuring devices, safety devices and similar pressure retaining components shall comply with Boiler & Pressure Vessels Act of Ontario and C.S.A. #B.51 in compliance with M.C.C.R. Technical Standards Division Directive of December 9, 1985 and Appendix 'A' thereto.

**2.2 PIPE & FITTINGS**

- .1 Buried interior drains laid on approved solid bedding shall be D.W.V. plastic P.V.C. solvent weld gravity sewer pipe (CSA #B182.1) SDR-28 to 150 mm size and SDR-35 for larger sizes. Use same material for wall hung urinals.
- .2 Unburied waste and storm piping shall be: 27.6 MPa class cast iron Soil Pipe CSA #B70 tar coated or DWV copper drainage pipe with solder fittings. Approved plastic pipe can be used if acceptable to Authorities having jurisdiction.
- .3 Interior Water Piping: Type 'K' or 'L' hard copper with solder pressure fittings for unburied NO ferrous piping, fittings, bushings or plugs shall be used. Provide Dielectric bushings at connections to ferrous materials. All copper water piping shall be certified for compliance with the ASTM B88-83 Standard, with certification markings on same.
- .4 Vent Piping: galvanized steel pipe schedule #40 (ASTM #A53) with 1035 kPa steam WP galvanized malleable fittings, copper 'DWV' pipe with solder fittings or 27.6 MPa class cast iron Soil Pipe. Approved plastic DWV above ground can be used above ground if acceptable to Authorities having jurisdiction.

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PLUMBING & DRAINAGE

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- .5 Exterior drains outside building: SDR-35 PVC sewer pipe (CSA #B182.1). Drain Pipe 200 mm size and larger may be un-reinforced concrete pipe, Class SS, CSA #A257.1, with rubber gasket with tongue and groove joint up to 2400 mm bury, Class ES up to 3600 mm bury and CSA #A257.2 Class IV over 3600 mm bury to approval. PVC piping shall NOT be used over 3600 mm depth of bury.

**2.3 VALVES**

- .1 Shut-off valves on branch lines to room fixtures and equipment up to and including 50 mm size may be brass ball valves rated for 1034 kPa WWP.
- .2 Provide Tour & Anderson Model 786 balancing valve c/w check and shut-off valve at each branch of hot water recirculation line.

**2.4 CLEANOUTS**

- .1 Cleanouts in concrete floor shall be Zurn #1602SP, Watts #CO-200-1-34, Mifab C1100 –R-1-34 Smith 4220 adjustable floor cleanout with round scoriated nickel bronze cover; in terrazzo areas with Zurn #1608SP, Watts #CO-200U-34 Mifab C1100-U-1-34 Smith 4180 cleanout cover; in tiled areas with Zurn #1603SP, Watts #CO-200T-34 Mifab C1100-T-1 Smith 4140 cleanout cover and Zurn #1504, Ancon #CO-200-RC, C1100-RC-1-34 Smith 4020Y in carpeted areas. In ceramic or quarry tile areas, cleanouts shall be as for terrazzo except with square top. In seamless floors cleanouts shall be Ancon #200FC or Zurn 1602-R6-SP, Watts 200-RFC-34, Mifab C1100-RFC-1 Smith 4220PC, or equal. All cleanouts must have inside gasketed C.I. plug. J.R. Smith are acceptable as an alternate.

**2.5 WATER HAMMER ARRESTORS**

- .1 Water hammer arrestors shall be PP In. or equal, sized and installed as per Manufacturer's recommendations. Provide unit in accordance with the following schedule:

<u>Model</u>	<u>Fixture Unit</u>
SC-500	Up to 11
SC-700	12 – 32
SC-1000	33 – 60
SC-1250	61 – 113

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PLUMBING & DRAINAGE

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**2.6 FLOOR DRAINS**

- .1 Floor Drains shall be as noted below.
- .2 Finished Floor - Floor Drains: Zurn 401-B, Watts #FD-100-C-A5-1, Mifab F1100-5-1 Smith 2005A lacquered cast iron floor drain with double drainage flange, weep holes, combined two piece body and reversible clamping device with adjustable 125 mm diameter, nickel bronze strainer with narrow slots with free area of 40.5 cm<sup>2</sup> minimum. Provide sediment bucket to floor drains located in Vehicle Decon, Apparatus Bays and each trench.
- .3 Unfinished or Concrete Floor - Floor Drains: Zurn 556, Watts FD-320-4, F1320-4 Smith 2005A lacquered cast iron floor drain with deep sump, seepage flange and integral clamping device, adjustable collar and galvanized or epoxy coated cast iron locking grate with minimum free area of 75 cm<sup>2</sup> and load capacity of 17.2 MPa (failure 31.7 MPa).
- .4 Funnel Floor Drains (FFD): Zurn 401-BF, Watts #FD-100-EG-1 F1100-EG-1 Smith 2320/3590 Finished Floor Drain fitted with 75 x 225 x 100 mm high nickel bronze oval funnel/strainer in lieu of round strainer.
- .5 Hub Drain: Zurn 415S, Watts FD-100-C-DD-50, Mifab F1100-DD-50 Smith 2005/2645 fitted with cast iron Hub type funnel.
- .6 Seamless or sheet vinyl floor drain: Zurn ZN-401R, Watts FD-100-FC, F1100-FC Smith 2051.
- .7 Catch basins (CB), trench drains will be provided by Another Section. Provide trap, vent and prime line to each unit and connect to sanitary sewage system.
- .8 Provide electronic fully recessed electronic trap seal primer with equalizing header and prime each trap of floor drain.

**2.7 FIXTURES & FITTINGS**

- .1 Provide plumbing fixtures shown or noted complete with necessary fittings and escutcheons of specified manufacturer. Fixtures and fittings shall conform to C.S.A. B45.1, B45.4 and B125 amended to date.
- .2 ALL plumbing fixtures shall be of one manufacture except where specifically noted as a special manufacture. ALL plumbing brass and trim shall be of one manufacture except where specifically noted as a special manufacture. Verify each fixture with millwork provided by Another Section. Fixture must be compatible type. No extra will be allowed if revisions is required due to millwork provided by Another Section.

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PLUMBING & DRAINAGE

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- .3 VERIFY mounting height of all fixtures with Architect BEFORE ROUGH-IN.
- .4 Submit three copies of fixture shop drawings for Owner's approval indicating room names and numbers where each fixture is located.

.5 Alternate Equipment:

Fixtures & Trim

- 1. Kohler
- 2. Zurn

Faucets:

- 1. Chicago Ceramic Cartridge
- 2. Powers Ceramic Cartridge
- 3. Zurn

Shower:

- 1. Acorn

Trims:

- 1. Powers
- 2. Zurn

Mop Service Basin

- 1. Stern Williams
- 2. Acorn

Drinking Fountain:

- 1. Acorn Aqua

Emergency Equipment

- 1. Speakman

.6 Toilet - Wall Mtd. Flush Valve (W-1)

American Standard AFWALL 3351.001 4.2 liters, 'Water Saver' Toilet, vitreous china elongated syphon jet action bowl, 38 mm top spud, with flange bolts, bolt caps, floor flange and gasket. Sloan Model 115-4.2 Regal flush valve, C.P. quiet action diaphragm type with vacuum breaker, seat bumper on angle stop, pressure loss check and with non-hold open feature. Olsonite #10CC, Centoco #1500 seat, Bemis 1955C elongated heavy duty solid plastic black open front less cover, with check hinges and chromated steel posts, washers and nuts. Provide Sloan Model WES 111-YG uppercut valves in all Female Washrooms. Provide floor supported chair carrier.

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PLUMBING & DRAINAGE

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- .7 Toilet - Wall Mtd. Flush Valve Barrier Free Design (W-2)  
American Standard AFWALL 3351.001, 4.2 litres Flowise 'Water Saver' toilet, vitreous china elongated syphon jet action bowl 38 mm top spud, with flange bolts, bolt caps, floor flange and gasket. Sloan Model 115-4.2 Regal flush valve, C.P. quiet action diaphragm type, vacuum breaker, centre seat bumper on valve, angle stop, pressure loss check and with non-hold open feature. Centoco #820ST Olsonite 46, Bemis 1950 seat, elongated heavy duty black solid plastic open front with cover, with check hinges and chromated steel posts, washers and nuts. Provide Sloan Model WES 111-YG uppercut valves in all Female Washrooms. Provide floor supported chair carrier.
- .8 Lavatory (L-1)  
Handbasin will be provided by Another Section. Provide Delta T3552LF-R#% faucet. Provide Delta 3070LF mixing valve and provide tempered water to hot side of faucet. Provide 33260 open grid strainer, 47T312 angle supply with S.D. stops, 33T311 'P' trap with cleanout and escutcheon plates.
- .9 Lavatory (L-2)  
Provided by Another Section. Provide Symmons SLW6712PP faucet and Delta 3070MIX-LF, thermostatic mixing valve, 33260 open grid strainer, 47T312 angle supply with S.D. stops, 33T311 'P' trap with cleanout and escutcheon plates.
- .10 Mop Service Basin (MSB)  
Fiat #TSBC1610 Terrazzo mop basin, 609 x 609 x 305 mm deep, complete with stainless steel dome strainer and lint basket; brass drain outlet for 75 mm inside caulk; Watts 909 backflow preventer on each supply, C.P. Delta 28C2384 combination wall mounted faucet with hose outlet and integral vacuum breaker mounted 900 mm above floor; 75 mm 'P' trap under floor. Caulk and seal floor basin to rear wall and floor to approval. Supply 762 mm length of 13 mm rubber hose Model 832-AA on faucet outlet. Include E-77-AA rim guard. Provide Watts 909 backflow preventer to each cold and H.W. supply line. Supply with each MSB one Haws 8901 c/w blending valve thermostatic eye/body wash.
- .11 (S-1) Two Compartment S.S. Sink  
Franke PS2X120-16-16-CA undermount, with crumb cup strainer. Franke EOSBR304 no pullout faucet, 'P' Trap cast brass, 38 mm with cleanout, union and escutcheon. Trim fitting Delta 26C3231, Faucet, C.P. 203 mm C.C. deck mounted, with cast brass body, swing spout with vandal proof flow aerator and cast metal lever handle. 33T311 'P' Trap, Connect with flexible tubes and 12.7mm rough Stops on supply piping.

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PLUMBING & DRAINAGE

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- .12 (S-2) Free-Standing Sink  
Supplied by Another Section. Provide Delta 55T1583 faucet, 38 mm P-trap with cleanout and stops on supply pipes.
- .13 (S-3) Single Compartment S.S. Sink  
Franke LBS6808, self-rimming, counter mounted, with crumb cup strainer, sound deadening. `P' Trap cast brass, 38 mm with cleanout, union and escutcheon. Trim fitting Delta 26C3231, Faucet, C.P. 203 mm C.C. deck mounted, with cast brass body, swing spout with vandal proof flow aerator and cast metal lever handle. 33T311 `P' Trap, Connect with flexible tubes and 12.7mm rough Stops on supply piping.
- .14 Shower (SH-1) - Standard  
Symmons Safety Mix 1-100 pressure balance mixing Shower Valve, heavy duty, limit stop, check stops, single control, metal lever handle and escutcheon, 4-141-145 5.7 L flow showerhead with bent arm and flange.
- .15 Shower (SH-2) - Handicap  
Symmons Safety Mix 1-25-FSB hand held shower pressure balance mixing valve and 5.7 L showerhead.
- .16 (DW) Dishwasher  
Supplied by Another Section installed by this Section. Rough-in and connect up domestic dishwasher supplied by Owner where shown. Provide 50 mm for commercial and 38 mm for domestic, trapped waste, 38 or 32 mm vent, 13 mm stops, and W-5 Shockstop on each supply.
- .17 Washer (W)  
Rough-in and connect up washer supplied by Owner. Provide Symmons W600-X laundry fitting; 38 mm trapped waste with 380 mm high standpipe; 32 mm vent and W-5 shockstop on each supply set below top of washer.
- .18 Eyewash (EW)  
Haws 7360BT-9201I hung, 19 mm CW and hot water supply and 32 mm P-trap.
- .19 Eyewash / Shower (EWSH)  
Haws 8330-9201, emergency eyewash/shower with mixing valve.

## 2.8 HOSE BIBBS

- .1 Exterior hose bibbs: Zurn #ZN-1320 or Mifab #MHY-20, 19 mm size wall hydrant with sleeve and nickel bronze box, loose key stop and integral backflow preventer.

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PLUMBING & DRAINAGE

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- .2 Interior water hose bibbs shall be Zurn Z-1341-PC-19 mm with hose valve, 19 mm inlet, hose end, and vacuum breaker. Provide reduced pressure type backflow preventer to each supply line.
- .3 Provide hot and cold water hose bibb Symmons Model 5-400 rated for 0.5 – 18 gpm @ 5 psi mixing valve for hose bibbs located in Apparatus Bay, as noted on Drawings and where hot and cold water hose bibbs are provided. Provide RP backflow preventer for each hose bibb.

**2.9 DRAIN VALVES**

- .1 Provide 19 mm lockshield 100# steam W.P. hose cock at main low points to drain each water type system. Provide 13 mm lockshield hose cock on each water type downfed unit.
- .2 Pipe outlets of relief valves, boiler and equipment drains and valves full size to end approximately 50 mm above Funnel Floor Drains. Pipe each outlet individually.

**2.10 BACKFLOW PREVENTER**

- .1 Provide Wilkins or Watts backflow preventer of reduced pressure types.

**2.11 DOMESTIC WATER HEATERS**

- .1 Provide two (2) ASHRAE approved A.O. Smith Model DEN-120, 450 litres glass lined hot water storage pre-wired and built for 125# ASME Code working pressure complete with insulated metal jacket, standard warranty, C.S.A. approval label and 13 mm drain cock. Tank shall have two (2) electric heaters each with capacity of 3000 watts at 208 volts, three phase with integral thermostat set 60°C. Heaters shall be wired for non-simultaneous operation.
- .2 Provide one (1) Amtrol St-20-C penumatic tank suitable for potable water for water heater.
- .3 Alternate Equipment:
  - 1. Bradford White

**2.12 FIRE EQUIPMENT**

- .1 Each Fire Extinguisher cabinet shall be National Fire Equipment Model #102RS recessed 1.6 mm prime coated steel cabinet with 2.8 mm gauge door and trim, 4.8 mm thick Lexan viewing panel and Corbin latch.

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PLUMBING & DRAINAGE

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- .2 Supply in each F.E. cabinet and where shown, U.L.C. #3A/10BC (2.27 kg) rated pressure power multi-purpose fire extinguisher complete with enamel steel jacket, pressure gauge, locking pin, hose and nozzle, hanger bracket.
- .3 Provide where later directed, U.L.C. #3A-10BC (2.27 kg) rated pressure powder multi-purpose extinguisher with baked enamel steel casing, pressure gauge and hanger: (total of 6 unit required).
- .4 Provide 6 litres Class 'K' fire extinguisher in each kitchen.
- .5 Alternate Equipment:
  - 1. Wilson & Cousin

**2.13 WATER METER**

- .1 Provide 50 mm size cold water meter c/w 4-20 milliamp output pulse reader for BMS and as approved by local Utility. Provide 150 mm high concrete base and secure meter in place to approval. Provide approved backflow preventer for water meter and install as instructed by Authorities.

**2.14 ELECTRIC PIPE TRACING**

- .1 Electric pipe tracing shall be Raychem XL-TRACE for freeze protection and HWT-Plus for temperature maintenance.
- .2 All pipe tracings shall be 120V/1/60 to suit Electrical Divisions requirements.

**2.15 OIL INTERCEPTOR**

- .1 Provide Zurn oil separator as shown on drawing. Oil interceptor shall be buried and reinforced to take buried depth, suitable for traffic load and must be prevented from floating.
- .2 Oil interceptor shall be Zurn Model 1186-700-K heavy duty suitable for fire truck loading with extension and vent connection.

**2.16 RECIRC PUMP**

- .1 Provide Armstrong all bronze circulator Model Astro 290, 218 watts with H/O/A starter.



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PLUMBING & DRAINAGE

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**2.17 ROOF DRAINS/ROOF HOPPER**

- .1 Control Flow Roof Drains Model Zurn Z-121-1 weir each or equal, cast iron body, integral clamp device, large protected sump, gravel guard, water proofing flange, bearing pan, large sump, under deck clamp, metal dome strainer.

**PART 3 - EXECUTION**

**3.1 TESTS**

- .1 In addition to tests required by local authorities, test new piping and drains in presence of Consultant as hereinafter described.
- .2 Notify Consultant in writing at least 48 hours prior to start of tests. Failure to do so may require test to be redone.
- .3 Ball test drains to Ontario Plumbing Code as amended to date.
- .4 Water test drains, storm, waste and vent piping to top of piping for not less than two hours without dropping in level.
- .5 Final air test drains, waste and vent piping to Plumbing Code.
- .6 Pressure test water piping with 1000 kPa cold water for not less than four hours without decrease in pressure. Test on buried water piping may be made after piping has been partially backfilled to hold in position but all joints shall be exposed to inspection.

**3.2 VENTING**

- .1 Vent fixtures and traps according to Plumbing Code and local regulations. Increase vents smaller than 75 mm diameter to 75 mm before same pass through roof.
- .2 Connect vent lines into soil and vent stacks above highest fixture or separately carry through roof. End soil stacks and vent piping 400 mm above roof.
- .3 Fit each soil and vent pipe through roof with vandal proof vent caps equal to Zurn Model Z-193.

**3.3 CONNECTIONS TO FIXTURES**

- .1 Trap each fixture and floor drain same size as outlet according to Plumbing Code. Vent each trap as outlined above where required by Plumbing Code.

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**PLUMBING & DRAINAGE**

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

<u>Fixture</u>	<u>Trap</u>	<u>Vent</u>	<u>Cold</u>	<u>Hot</u>
Lavatory	32 mm	32 mm	13 mm	13 mm
Water Closet	75	38	25	-
Sink (Single or Double)	38	32	13	13
Floor Drains	75 Min.	38	10	-
Drains	100	38	10	-
Eyewash Shower	100	38	32	32
Eyewash	32	32	13	13

**3.4 JOINTS**

- .1 Make all joints in piping to conform to Plumbing Code and to approval.
- .2 Make joints in copper waste, vent and water piping with certified lead free solder with non-corrosive soldering flux. Clean and ream each joint and remove excess solder and flux. Other lead free solders giving equivalent strength joints may be used.
- .3 Buried copper water pipe to be continuous with no joints.
- .4 Make joints in threaded pipe with lead free joint compound. Use of lampwick or hemp will not be permitted.

**3.5 PIPE & FITTINGS**

- .1 Provide all necessary piping including fittings, unions, etc., to complete systems shown. Cut pipes true and square, ream or file ends to smooth surface, all to pipe manufacturer's and accepted trade standards. Fittings shall be of equivalent bore as pipe, of equal strength and weight. Install piping to manufacture's specifications and published directions. All piping shall conform to Plumbing Code.
- .2 Chrome plate all exposed uninsulated pipes, fittings and valves in washrooms and other occupied areas unless otherwise directed.
- .3 Provide flanges, unions or compression fittings on equipment side of shut-off valves in piping connections to equipment, tanks and fixtures so same can be disconnected for service. Flanges and unions shall be of same material as piping.

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PLUMBING & DRAINAGE

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**3.6 VALVES**

- .1 Provide valves of types noted as required for ease of maintenance and operation.
- .2 Provide shut-off valves on water piping leading to each battery or group of 2 or more fixtures whether or not shown. Each washroom shall be considered as a group and be valved as a unit unless valved in two or more groups. Locate for easy operation through suspended ceilings and access doors.
- .3 Provide shut-off valve at top or base of each domestic water and branch main.
- .4 Provide check valve, shut-off valve and Tour & Anderson Model 786 circuit balancing valve suitable for potable water system on each circulation branch pipe.

**3.7 DRIPS & DRAINS**

- .1 Provide 13 mm lock-shield brass hose cocks at base of each water riser, on branch mains and runouts and at low points, set on riser or fixture side of shut-off valves. Provide sufficient valves to ensure complete draining of all water piping.

**3.8 EXPANSION PROVISIONS**

- .1 Install piping to allow for expansion and contraction complete with swing joints as necessary.
- .2 Anchor and guide piping where necessary.

**3.9 CLEANOUTS**

- .1 Provide cleanouts to conform to Plumbing Code. Grease cleanout plugs and covers BEFORE installation. Open and clean each cleanout after floors are finished to ensure easy access for cleaning. Enpoco products are acceptable.
- .2 Make each cleanout full size of drain up to and including 100 mm, and 100 mm size for drains over 100 mm. Extend buried cleanouts up to floor with 'Y', 1/8th bend and recessed brass plug.
- .3 Make each cleanout accessible and wherever necessary, extend branch connections to finished surfaces of walls and floors and fit with cleanout cover and access door.

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**PLUMBING & DRAINAGE**

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- .4 Extend cleanouts on drains outside building in grassed areas up to grade with 100 mm size 'Y' and '1/8th bend' in 27.6 MPa class Soil Pipe and fit with solid brass recess plug in top. Provide necessary support for soil pipe and finish cleanout flush with grade in approved manner set in 300 x 300 x 150 mm deep concrete pad.
- .5 Provide "Barrett" type cleanout in base of each soil and vent stack and each rainwater leader.
- .6 Provide 'Y' type line cleanout on each waste pipe and stack 50 mm size and smaller extending vertically above grade floor immediately before same becomes buried.
- .7 Provide cleanout at each wall hung urinal complete with C.P. access door and frame.

**3.10 FLOOR DRAINS**

- .1 Provide Floor Drains of types noted, where shown or directed, complete with strainer and accessories noted or required to complete installation. Set each drain to required level to approval.
- .2 Trap and vent each Floor Drain as required by Code. Provide 13 mm valved water line for each primer. Provide equalizing header and pipe to each trap. Trap seal each with 10 mm copper water line by automatic trap seal primer and strainer on cold water line. Where more than one floor drain unit is fed from common water supply, provide equalizing header.

**3.11 PIPE GRADING**

- .1 Unless otherwise noted, drains and waste piping shall grade DOWN in direction of flow as follows:  
  
Up to and including 75 mm size - 1:50  
100 mm size and larger - 1:100
- .2 Grade Hot and Cold Water piping UP in direction of flow 1:240. Grade circulation piping DOWN in direction of flow at 1:240.
- .3 Grade Vent piping UP from fixtures so it is self-draining. Minimum grade shall conform to Plumbing Code.
- .4 Grade H.W. heating piping 'UP' in 1:240 to air vents. Arrange piping to ensure minimum number of vents.

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PLUMBING & DRAINAGE

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- .5 Grade equipment drain and waste piping 'DOWN' 1:240 minimum to waste receptacle.

**3.12 FIXTURES & FITTINGS**

- .1 Set bolt caps and escutcheons in plaster of paris. Hang each fixture to manufacturer's standards using all bolt holes and secure to wall to approval. Provide floor supported chair carrier for all wall hung fixtures including lavatories and urinals.
- .2 Architectural drawings to govern in determination of number and location of fixtures. Supply and install complete with all services every fixture shown on any Contract Drawing.
- .3 Provide electric wiring to all sensor operated faucets.

**3.13 TEMPORARY WATER**

- .1 Arrange and bring in permanent water service immediately after Contract is signed and service available.
- .2 Provide off water service, temporary water connection at point agreeable to General Contractor and Consultant where construction water may be obtained by trades engaged. Maintain service in working condition until water is available from building services.
- .3 Locate flush valves for handicap fixtures on open side of wall and not to face towards grab bar.

**3.14 HOSE BIBBS**

- .1 Provide hose bibbs where shown and as noted. Each exterior hose bibb shall be complete with shut-off valve inside wall mounted not less than 460 mm above grade to approval. Mount interior hose bibbs as noted.
- .2 Mount interior hose bibbs 1070 mm above floor with wing back elbow unless otherwise noted.

**3.15 BACKFLOW PREVENTER**

- .1 Install unit to Manufacturer's recommendations. Pipe drain port to nearest funnel floor drain to approval.
- .2 Locate each backflow preventer 1500 mm above floor.

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PLUMBING & DRAINAGE

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**3.16 DOMESTIC WATER HEATERS**

- .1 Mount each heater on wall to approval. Provide drain-off on each unit. Pipe each relief valve to 50mm open waste at upstream of sink trap. Provide 13 mm Watts #36A vacuum relief valve on each tank inlet after shut-off valve above top of tank.
- .2 Provide a shut off valve and check valve to water line serving heater. Provide a valved 13mm line from downstream of check valve to pneumatic tank.
- .3 Before installing heaters, arrange with Manufacturer for supervised installation and entire work shall be as recommended and approved by Manufacturer and Architect. Heater Manufacturer shall submit written report to Architect.

**3.17 TEMPORARY WATER**

- .1 Arrange and bring in permanent water service immediately after Contract is signed and service available.
- .2 Provide off water service, temporary water connection at point agreeable to General Contractor and Consultant where construction water may be obtained by trades engaged. Maintain service in working condition until water is available from building services.

**3.18 WATER SERVICE**

- .1 Connect domestic water service at 1500 mm face of building provided by Another Section and extend to water meter located inside building. Provide anchor bolt and thrust block to each fitting. Work and material must comply to Region of Peel requirements.
- .2 Anchor each bend, tee, valve, and branch with 15 Mpa cast in place concrete to Utility Standards.

**3.19 WATER METER**

- .1 Provide cold water meter as shown. Install on 150 mm high concrete base provided by this Section and secure meter in place to approval.
- .2 Provide line size shut-off valves on both sides of meter, meter size valved bypass, test valve and 19 mm size drain valve piped to Funnel Floor Drain and pressure gauge at c/w valve at downstream of meter. Maintain clearances required by Utility.

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PLUMBING & DRAINAGE

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- .3 Provide sleeves in wall and make provisions for future installation of remote meter reader unit by Utility.
- .4 Provide backflow preventer at downstream of water meter. Provide a pressure reducing valve c/w shut-off valves, pressure gauges at inlet and outlet and valve bypass line if incoming water pressure is more than 80 psi.

**3.20 STORM DRAINAGE SYSTEM**

- .1 Provide storm drainage system to all roof hoppers and connect to storm lines provided by Another Section at 1500 mm face of building maintaining required elevation.

**3.21 SANITARY SYSTEM**

- .1 Provide sanitary sewage system to all plumbing fixtures, floor drains and connect to sanitary line provided by Another Section at 1500 mm face of building maintaining required elevation.

**3.22 OIL INTERCEPTOR**

- .1 Install oil interceptor to meet Manufacturer's recommendations and pipe up the holding tank.
- .2 Provide vent lines to meet Plumbing Code and local Authorities requirements.
- .3 Install oil level sensor kit and control panel. Provide all required wiring from outlet provided by Electrical Division.

**3.23 RECIRC PUMP**

- .1 Mount recirc. pump approximately 1 meter above floor.
- .2 Provide manual starter. Pump shall be interlocked to cycle from EMS.
- .3 Wiring of pump and starter by Electrical Division.

**3.24 ROOF DRAINS/ROOF HOPPER**

- .1 Provide roof drains as noted on the drawing. Roof drains shall be c/w accessories noted and required to complete installation. Verify roof hopper type to be compatible with roof construction.

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PLUMBING & DRAINAGE

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**3.25 CONNECTIONS FOR OTHER SECTIONS**

- .1 Provide water and waste connections required for equipment of Owner or other Sections. Examine drawings and specifications and co-operate with Owner and other Sections to extent of properly locating connections required.
- .2 Special valves and controls shall be supplied by Owner or other Sections concerned and wastes shall be made to F.F.D. or other drains left by this Section in accordance with Plumbing Code. Provide globe valve on each water supply, check valve and Watts #909S backflow preventer and strainer to meet Plumbing Code. Pipe drain port of B.F.P. to nearest F.F.D. as required.

**3.26 OPERATE AND ADJUST SYSTEMS**

- .1 Operate all systems to full capacity and verify proper, safe efficient operation of all parts and of each complete system.
- .2 Adjust flush valves, flush tanks, controls and valves to give proper performance and to required settings. Oil motors and grease bearings before operating equipment.
- .3 Turn over to Owner, necessary keys, handles and operating devices for each system.

**3.27 WARRANTY**

- .1 Furnish to Owner through General Contractor and Architect, written warranty covering materials and workmanship and free service for one year from date of start of lien period.
- .2 Warranty shall entail repair and replacement of materials without charge to Owner except where, in opinion of Architect, such repair or replacement was caused by improper use or lack of maintenance.

END OF SECTION



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TESTING, ADJUSTING, BALANCING

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
<u>PART 1 - GENERAL</u>	
1.1	General Conditions
1.2	Summary
1.3	Qualifications to TAB Personnel
1.4	Purpose of TAB
1.5	Exceptions
1.6	Co-ordination
1.7	Pre-TAB Review
1.8	Start-Up
1.9	Operation of Systems during TAB
1.10	Start of TAB
1.11	Application Tolerances
1.12	Accuracy Tolerances
1.13	Instruments
1.14	Submittals
1.15	Preliminary TAB Report
1.16	TAB Report
1.17	Verification
1.18	Settings
1.19	Completion of TAB
1.20	Air Systems
1.21	Hydronic Systems

---

TESTING, ADJUSTING, BALANCING

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**PART 1 - GENERAL**

**1.1 GENERAL CONDITIONS**

- .1 Read and conform to:
  - .1 The Contract CCDC 2-2009, Stipulated Price Contract as amended in the Contract Documents;
  - .2 Division 1 requirements and documents referred to therein.

**1.2 SUMMARY**

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.
- .3 The work under this Section will be paid for by the Mechanical Contractor.

**1.3 QUALIFICATIONS OF TAB PERSONNEL**

- .1 Submit names of personnel to perform TAB to Engineer within 30 days of award of contract.
- .2 Qualifications: personnel performing TAB current member in good standing of AABC and NEBB.
- .3 Quality assurance: perform TAB under direction of supervisor qualified to standards of NEBB.
- .4 Provide documentation confirming qualifications, successful experience.
- .5 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
  - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
  - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
  - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

#### TESTING, ADJUSTING, BALANCING

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- .6 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .7 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .8 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .9 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .10 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
  - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
  - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

#### 1.4 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

#### 1.5 EXCEPTIONS

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

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TESTING, ADJUSTING, BALANCING

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**1.6 CO-ORDINATION**

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

**1.7 PRE-TAB REVIEW**

- .1 Review contract documents before project construction is started and confirm in writing to Engineer adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Engineer in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

**1.8 START-UP**

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

**1.9 OPERATION OF SYSTEMS DURING TAB**

- .1 Operate systems for length of time required for TAB and as required by Engineer for verification of TAB reports.

**1.10 START OF TAB**

- .1 Notify Engineer 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.

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TESTING, ADJUSTING, BALANCING

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- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
  - .1 Proper thermal overload protection in place for electrical equipment.
  - .2 Air systems:
    - .1 Filters in place, clean.
    - .2 Duct systems clean.
    - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
    - .4 Correct fan rotation.
    - .5 Fire, smoke, volume control dampers installed and open.
    - .6 Coil fins combed, clean.
    - .7 Access doors, installed, closed.
    - .8 Outlets installed, volume control dampers open.
  - .3 Liquid systems:
    - .1 Flushed, filled, vented.
    - .2 Correct pump rotation.
    - .3 Strainers in place, baskets clean.
    - .4 Isolating and balancing valves installed, open.
    - .5 Calibrated balancing valves installed, at factory settings.
    - .6 Chemical treatment systems complete, operational.

**1.11 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
- .2 HVAC systems: plus 5%, minus 5%.

**1.12 ACCURACY TOLERANCES**

- .1 Measured values accurate to within plus or minus 5% of actual values.

**1.13 INSTRUMENTS**

- .1 Prior to TAB, submit to Engineer a list of instruments to be used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Engineer.

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TESTING, ADJUSTING, BALANCING

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**1.14 SUBMITTALS**

- .1 Submit, prior to commencement of TAB:
- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

**1.15 PRELIMINARY TAB REPORT**

- .1 Submit for checking and approval of Engineer, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
  - .1 Details of instruments used.
  - .1 Details of TAB procedures employed.
  - .2 Calculations procedures.
  - .3 Summaries.

**1.16 TAB REPORT**

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .3 Submit 6 copies of TAB Report to Engineer for verification and approval, in English in D-ring binders, complete with index tabs.

**1.17 VERIFICATION**

- .1 Reported results subject to verification by Engineer.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Engineer.
- .4 Pay costs to repeat TAB as required to satisfaction of Engineer.

**1.18 SETTINGS**

- .1 After TAB is completed to satisfaction of Engineer, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

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TESTING, ADJUSTING, BALANCING

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**1.19 COMPLETION OF TAB**

- .1 TAB considered complete when final TAB Report received and approved by Engineer.

**1.20 AIR SYSTEMS**

- .1 Standard: TAB to most stringent of TAB standards of AABC, NEBB and SMACNA.
- .2 Do TAB of following systems, equipment, components, controls:
  - .1 Heat pumps
  - .2 Heat Recovery Unit
  - .3 Exhaust Fans
  - .4 Controls
- .3 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .4 Locations of equipment measurements: to include as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.
- .5 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).
- .6 Provide systems leakage tests to SMACNA Class 12 requirements.

**1.21 HYDRONIC SYSTEMS**

- .1 Standard: TAB to most string of TAB standards of AABC, NEBB & SMACNA.
- .2 Do TAB of following systems, equipment, components, controls:
  - .1 Heat pumps
  - .2 Pumps
  - .3 Heat Recovery Unit
  - .4 Controls
- .3 Measurements to include as appropriate for systems, equipment, components control: water flow rate, pressure drop and temperature, RPM, electrical power, voltage, noise, vibration.

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TESTING, ADJUSTING, BALANCING

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- .4 Location of equipment measurement to include as appropriate:
  - .1 Balancing Valves
  - .2 Controllers Controlled Devices.
  
- .5 Locations of system measurements to include as appropriate:
  - .1 Main supply pipes
  - .2 Branch pipes
  - .3 CBV at each heat pumps.
  - .4 Triple daily value at pumps.

END OF SECTION



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LIQUID HEAT TRANSFER

---

CONTENTS

SUBSECTION

TITLE

PART 1 - GENERAL

1.1	Related Instructions
1.2	Work Included
1.3	Submittals

PART 2 - PRODUCTS

2.1	Materials
2.2	Pipe & Fittings
2.3	Valves
2.4	Expansion Provisions
2.5	System Venting
2.6	Water Feed Pressure Regulator
2.7	Expansion Tanks
2.8	Air Separator
2.9	Water Treatment Equipment
2.10	Flow Measuring Equipment
2.11	Strainers
2.12	Thermometers & Gauges
2.13	Water Pumps
2.14	Flow Switches
2.15	Buried Earthloop Piping
2.16	Earthloop Thermal Fluid
2.17	Unburied Earthloop Piping
2.18	Water Treatment Equipment
2.19	Heat Pumps
2.20	Variable Frequency Drive

Continued.....

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LIQUID HEAT TRANSFER

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
<u>PART 3 - EXECUTION</u>	
3.1	Piping Tests
3.2	Pipe & Fittings
3.3	Welding
3.4	Valves
3.5	Expansion Provisions
3.6	Pipe Grading
3.7	System Venting
3.8	Drain Valves
3.9	Air Separator
3.10	Expansion Tank
3.11	Water Treatment Equipment
3.12	Cleaning & Flushing Systems
3.13	Water pumps
3.14	Flow Measuring Equipment
3.15	Strainers
3.16	Thermometers & Gauges
3.17	Earthloop Thermal Fluid
3.18	Buried Earthloop Piping
3.19	Heat Pumps
3.20	Variable Frequency Drives
3.21	Operate and Adjust Systems
3.22	Quiet Operation
3.23	Warranty

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LIQUID HEAT TRANSFER

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**PART 1 - GENERAL**

**1.1 RELATED INSTRUCTIONS**

- .1 Comply with requirements of Section 21 05 01, Mechanical General Requirements.

**1.2 WORK INCLUDED**

- .1 Work under this contract shall include but is not limited to the following:
  - .1 Supply and installation of H.V.A.C. Systems described in this specification and in the Tender Drawings.
  - .2 Installation of ground loop system.
  - .3 Supply and installation of other components, accessories and incidentals to complete above systems and miscellaneous items as noted.

**1.3 SUBMITTALS**

- .1 Submit Shop Drawings for following:
  - 1. Pipe & Fittings
  - 2. Valves
  - 3. Expansion Provisions
  - 4. System Venting
  - 5. Waterfeed Pressure Regulator
  - 6. Differential Pressure Valves
  - 7. Expansion Tank
  - 8. Water Treatment Equipment
  - 9. Flow Measuring Equipment
  - 10. Strainers
  - 11. Thermometers & Gauges
  - 12. Water Pumps
  - 13. Flow Switches
  - 14. Heat Pumps
  - 15. Thermal Fluid
  - 16. Variable Frequency Drives

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- .1 Materials shall be of Canadian manufacture where available, of best quality of their respective kinds and of uniform pattern throughout.

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## LIQUID HEAT TRANSFER

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- .2 All pipe fittings, valves, expansion joints, strainers, steam traps, measuring devices, safety devices and similar pressure retaining components shall comply with Boiler & Pressure Vessels Act of Ontario and C.S.A. #B.51 in compliance with M.C.C.R. T.S.S.A. of December 9, 1985 and Appendix 'A' thereto.

### 2.2 PIPE & FITTINGS

- .1 Unburied piping: Victaulic standard weight couplings and fittings with "EPDM" gaskets, all to conform to CSA #B-24-2 amended to date.
- .2 Fittings on unburied piping up to and including 50 mm size: 862 kPa steam WP black cast iron ANSI #B16.4. Fittings on 63 mm size and larger: #B16.9 butt-welding type with bends and reducing couplings manufactured welding fittings with branches welded directly into mains where 2 sizes or more smaller than main. Fittings on low temp. piping (4° – 38 ° C) shall be victaulic or couplox standard weight couplings and fittings with EPDM gaskets all to conform to CSA #B-242 amended to date. In Mechanical Rooms, use Zero-Flex couplings to give system rigidity, gaskets must be compatible with Loopanol-2 thermal fluid.
- .3 Domestic water feed systems piping inside cabinets on copper/aluminum elements: type 'L' hard copper piping with solder joint pressure class fittings. Joints shall be made with 95/5 strength lead free solder and non-corrosive soldering flux. Provide dielectric fittings at connections to ferrous materials on cold water supply.
- .4 Equipment condensate drain and waste water piping: type 'L' or 'DWV' copper piping with solder joint drainage fittings, 95/5 strength lead free solder.
- .5 Buried piping (all systems unless otherwise specified polyethelyn) shall be extra heavy black steel pipe, Schedule #80 ASTM#A53.
- .6 Fittings on buried piping: forged steel 13.8 MPa steam WP socket welding type ANSI #B-16.11 up to and 32 mm size. Fittings 38 mm size and larger, 2070 kPa steam WP, ANSI #B16.9 butt welding type.

### 2.3 VALVES

- .1 Valves shall be Crane, Jenkins or Toyo (Industrial Class) manufacture, all-brass up to and including 50 mm size. Larger sizes shall be iron body, bronze mounted. Valves shall be for 862 kPa steam working pressure or equivalent. Valves 100 mm size and larger shall be flanged. Valves shall be ball type.
- .2 Shut-off valves, up to and including 50 mm size shall be ball type.

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## LIQUID HEAT TRANSFER

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- .3 Shut-off valves 63 mm size and larger: Crane, DeZurik, Toyo, Jenkins, Demco, or Keystone gate valves rated for 150# W.P., 135°C with bronze or alum/bronze disk, 18-8 S.S. shaft, EPT liner, 3 bearings, manual lockable lever operator, positive seal, conforming to MSS Standard SP-67 for dead end service with one flange disconnection. Valves 200 mm size and larger shall have manual screw operators.
- .4 Check valves: of same materials and pressures as specified for butterfly valves above, of swing check type with regrinding feature. Install check valves in horizontal position only. Mission (Ontor Ltd.) "Duo-Check" #15SMF, Proquip Valve Inc. or Rite Mfg. Ltd. check valves may be used in vertical position.
- .5 For throttling type valves, see Article 2.16, Flow Measuring Equipment.
- .6 All valves shall be compatible with propylene glycol.

### 2.4 EXPANSION PROVISIONS

- .1 Provide on piping connections, and where shown on drawings as "FC", line size Flexonics 'BSF' stainless steel braided flexible connectors for 1035 kPa WP with ANSI flanged ends. Provide fire rated condensate hoses for heat pump drains. Provide the same on all pipes crossing structural expansion joints (see Structural drawings).
- .2 Provide on piping connections to each circulating pump, line size Flexonics 'BSF' stainless steel braided flexible connectors for 1035 kPa WP with ANSI flanged ends. Provide base elbow on neoprene pad at each pump suction.
- .3 Alternate Equipment:
  - 1. United Flexible Metallic Tubing (Can) Ltd.
  - 2. Anaconda (Hydro-Flex Hose Ltd.)
  - 3. Vibra-Flow Inc.

### 2.5 SYSTEM VENTING

- .1 Automatic air vents shall be Braukman #EA-122 or equal with integral shut-off.

### 2.6 WATER FEED PRESSURE REGULATOR

- .1 Provide on cold water supply to floor heating system, a Braukman Controls Co. Ltd. #VF126 feed water pressure regulator complete with brass body, integral shut-off valve, strainer and check valve and kPa scale gauge. Regulator shall be of balanced single seated type, built for 862 kPa W.P. with 140 kPa (20#) outlet pressure.

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LIQUID HEAT TRANSFER

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**2.7 EXPANSION TANKS**

- .1 Provide under floor heating loop Trol internal diaphragm type expansion tank precharged to system fill pressure (approximately 140 kPa), built of steel construction, ASME approved for at least 690 kPa working pressure and complete with line size lockshield inlet valve and air charging valve. Provide lockshield valve on piping connection to each system.
- .2 Expansion tanks shall be compatible with propylene glycol.
- .3 Alternate Equipment
  1. Taco (Canada) Ltd.
  2. Expanflex

**2.8 AIR SEPARATOR**

- .1 Separators shall be line size S.A. Armstrong type #VA Vortex air separator, with steel shell and removable air collection tube. Unit shall comply with ASME Code.
- .2 Alternate Equipment:
  1. Bell & Gosset
  2. Taco

**2.9 WATER TREATMENT EQUIPMENT**

- .1 Supply equipment, chemicals and components to give complete system of water treatment for various piping circuits as detailed hereinafter based on Drew Chemical Co. Ltd. equipment and materials.
- .2 By-Pass Feeders
  1. Supply Drew By-Pass Feeders for each of following systems:
    - Heating System - Type "HV" (7.5 Litre Capacity)
  2. Bypass feeders shall have steel bodies complete with vent, check, isolating and drain valves.
- .3 By-Pass Filters
  - .1 Provide Drew Model 3 CMC (3 Cartridge Type) heating Systems.
  - .2 Filters shall be steel bodied, contain three 10" filter cartridges, be suitable for 150# service and flow rates of 20 to 115 litres per minute. Supply carton of 30 Filter Cartridges, Type R50A10T.
- .4 Supply following chemicals in addition to those used for cleaning systems:
  - .1 Cleaner - for each Recirculating Water System, two 23 Litre Pails Ferroquest 345 (total of 4 pails).

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LIQUID HEAT TRANSFER

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- .2 Chemical for Closed Systems
  - Five 20 litre pails DREW 545 Molybdate corrosion control.
  - Drew Type 'S' Test Cabinet with light and lock.
  - Nitrite Test Kit (#2508)
  - Organic Test Kit (#920)
  - "P", "M" and "C1" Test Kit (#2551)

- .5 Alternate Equipment
  - 1. Finnan Eng. Products Ltd.
  - 2. Dearborn

**2.10 FLOW MEASURING EQUIPMENT**

- .1 Fittings up to 50 mm size shall be Model CBV1 screwed end circuit balancing fitting with shutoff/balancing valve, drain connection and meter connections. Fittings over 50 mm size shall be Model CBV-11 flanged end circuit balancing fitting with valved meter connection and shutoff/balancing valve. Fittings shall be rated for 862 kPa working pressure. Provide circuit balancing valve for every underfloor heating manifold heating and where shown on the drawings.
- .2 Supply one Armstrong "Compuflow" digital meter complete with carrying case, hoses and operating instructions. Turn over to Owner on completion of system balancing.
- .3 Alternate Equipment:
  - 1. Taco
  - 2. Tour & Andersson

**2.11 STRAINERS**

- .1 Strainers shall be 'Y' type, full line size of piping, of Sarco manufacture with cast iron or semi-steel body for 862 kPa W.P. with stainless steel or monel basket screen with 4.8 mm holes.
- .2 Alternate Equipment:
  - 1. Trane Co. of (Canada) Ltd.
  - 2. Lunkenheimer Canada Ltd.
  - 3. Hayward (Ontor Ltd.)
  - 4. Colton Industries

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LIQUID HEAT TRANSFER

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**2.12 THERMOMETERS & GAUGES**

- .1 Thermometers shall be Trerice #BX93403-1/2 red reading mercury, 228 mm stem type with cast aluminum case and forged brass separable socket, adjustable angle with brass separable well and plexiglass window, range 0 to 115°C with combined C/F scale.
- .2 Pressure gauges shall be Trerice #600/C, 114 mm dial with cast aluminum case, phosphor bronze bushed rotary type movement and bourdon tube, black finish case and figures, white face with dampening insert and plexiglass window, range 0 to twice working pressure complete with 6.4 mm brass cock, snubber fitting and combined Metric/Imperial scale.
- .3 Alternate Equipment:
  1. Baker Instrument Ltd.
  2. Winters Thermogauges Ltd
  3. Weksler Instruments Corp.
  4. Taylor Instruments Ltd.
  5. Ashcroft (Dresser Industries Canada Ltd.)

**2.13 WATER PUMPS**

- .1 Select motors to operate equipment at proper efficiency without overloading, see 210501 Wiring & Motors, for further details such as start-up times. Each motor shall operate at 30 r/s maximum unless otherwise specifically noted and be of Canadian manufacture. Motors to be high efficiency, see 210501.
- .2 On floor heating pumps, motor shall be inverted duty rated as per NEMA-MG1 Part 31.
- .3 Each pipe mounted pump shall be horizontally mounted circulator complete with rubber mounted, open protected continuous duty motor, remite water seal, spring coupling, brass thrust collar, bronze bearings, oil reservoir and wool wick oiling system, cast iron body, steel cadmium plated impellor, alloy steel shaft and copper shaft sleeve with carbon rotating seal.
- .4 Alternate Equipment:
  1. Taco
  2. B & G (ITT Industries)

**2.14 FLOW SWITCHES**

- .1 Provide on return piping at each pump McDonnell-Miller #FS7-4 SPDT water flow switches, for central control panel control.



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LIQUID HEAT TRANSFER

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**2.15 BURIED EARTHLOOP PIPING**

- .1 Equipment and installation shall be by an approved specialty sub-contractor having at least 3 years experience in this type and size of work and having at least 2 similar projects in service at time of bidding.
- .2 The earthloop system contractor shall bid to the mechanical contractor and NOT to the Heat Pump manufacturer. Work of this sub-contractor shall include all related site work and piping up to the steel pipes connection beside the mechanical room.
- .3 The earthloop contractor must have a contractor's license and technician license issued by the Ministry of the Environment (MOE). The earthloop contractor shall be licensed by the Canadian Earth Association (CEEA). He shall be able to perform the requirements of drilling the holes, installing the loops and grouting to both MOE and CEEA specs. He shall have modern equipment capable of performing these functions in a reasonable period of time. He shall have gas detection equipment on site connected and operating.
- .4 System shall include buried earthloop system where shown consisting of reverse supply and reverse return headers and multiple heat exchanger loops drilled into ground.
- .5 Earthloop contractor must ensure that noise level from his operations does not exceed 55 decibels at the property line.
- .6 Earthloop contractor shall provide all earthloop piping exterior to building and up into the building as shown where steel pipe starts. Exterior work includes all horizontal and vertical piping, excavating, backfilling, drilling etc. for this piping.
- .7 Earthloop piping materials shall be in compliance with CSA Standard #B123.1 regarding piping materials for ground source heat pumps. Earthloop pipe shall be Series (160#WWP) #8406 or #3406 resin polyethylene extruded to Schedule 40 I.P.S.
- .8 Vertical earthloops of diameter shown shall be installed in boreholes drilled to depths as shown on Drawings. Earthloop boreholes shall be drilled where shown unless site conditions (slabs, foundations services) change and dictate otherwise. Provide metal sleeves where required to suit ground conditions.
- .9 Each vertical pipe loop shall be ready to install and be inserted into borehole as soon as drill stems are removed so as to minimize time for cave-ins and to maximize opportunity for even heat exchanger lengths.

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LIQUID HEAT TRANSFER

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- .10 Space between any two boreholes shall be no closer than 45 meters (15 feet). All boreholes shall be no closer than 3 m to any building, service, waterline or sewer area..
- .11 Remove drilled out material from site unless otherwise directed. Excavate and backfill trenches as noted in 210501-17 and 18. Provide written report confirming that all vertical piping has been backfilled as specified and that all buried horizontal earth loop piping has been backfilled with sand and rigid insulation installed as specified and shown on Drawings.
- .12 All heat pump holes must be completely sealed with impermeable materials to prevent downward migration of contaminants and intermixing of aquifer complexes. Drilling contractors shall provide a bentonite clay/cement mixture to the full depth of each hole. The grouting shall be tremmied or pressure grouted from the bottom of each hole and upward. This must be repeated as required until grouting is cured and settlement is completed.
- .13 For anticipated drilling conditions see test bore hole information which is part of the architectural specifications. Closed Loop Ground Source Sub-Contractors should check local conditions before submitting drilling price. See also soil test report prepared by Geotechnical Consultants and included as part of the architectural specification.
- .14 Vertical earth loop heat exchangers shall be connected together in reverse return fashion where shown 1.5 meters below final grade level. Any breaking of rocks to achieve 1.5 meters deep trenches is the responsibility of the Ground Source Sub-contractor.
- .15 Building entry shall be through steel pipe culverts from exterior wall to at least 1500 mm beyond exterior wall approximately 1500 mm to top below finished grade. Each steel culvert shall have 50 mm thick Dow 'SM' glued to conduit through full length. Where piping enters conduit at wall, seal watertight and also seal conduit at entry end. Each conduit shall be capped off with quick drying cement and earth loop entry stub shall extend 300 mm minimum past cement cap. Seal buried end water tight. See Detail.
- .16 Closed loop ground source Sub-Contractor shall have current C.E.E.A. Certified Technician in both butt fusing and socket fusing procedures and techniques. Document must be on site at all times while working is in progress.
- .17 All outside connections shall be fused in field at 254°C to 265°C (490°F to 510°F). No non-fused joints in field will be permitted. U-bends for vertical boreholes shall be butt fused.

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LIQUID HEAT TRANSFER

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- .18 Use minimum of plastic elbows and fittings etc. and maximize flexibility of earth loop pipe material so as to minimize pressure drop throughout system.
- .19 Excavation and backfilling for earthloop system shall be by this section. Refer to Soils Report and Drilling Report. Make due allowance for these conditions in tender price. Include all necessary costs in tender price to accommodate and include all conditions shown in both reports. Both reports are included in the Architectural specifications.

**2.16 EARTHLOOP THERMAL FLUID**

- .1 Heat pump system shall have antifreeze solution of 30 % (by volume) Propylene Glycol.
- .2 The solution shall be premixed off site and trucked to site for pumping into the ground loop system using purging unit. Completely fill entire system venting off all air except in expansion tank leaving 275 kPa residual pressure in system.
- .3 Provide Propylene Glycol solution make-up for ground source loop as shown. Provide 25 mm pipe from pump located in 205 litre drum to top of 250 dia. supply header with shutoff valve and low flow sensor as shown. Install control pressure switch in return header and wire to heat pump central control panel. Feed pump shall be explosion proof with spark proof motor to suit low flash point thermal fluid.
- .4 All components on Propylene Glycol system shall be suitable for solution used. Pump seals, gaskets, expansion tanks, valves and other materials must not be affected and have normal life span. Where solution will affect normal life span, provide alternate materials to meet this requirement.

**2.17 UNBURIED EARTHLOOP PIPING**

- .1 Provide supply and return headers of size shown complete with shut-off and balancing valves.
- .2 Conversion to steel pipe shall be by flanged polyethylene to steel pipe fittings of appropriate size. Make final connection to each header inlet/outlet.
- .3 Insulate interior polyethylene earthloop piping with 19 mm Armaflex II or Acwil "Therma-Cel" flexible foamed elastomeric insulation with fittings and valves insulated to match. Interior insulation shall be left ready for painting by another Section. Insulation must be sealed to adjoining insulation over polyethylene pipe.

**2.18 WATER TREATMENT EQUIPMENT**

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LIQUID HEAT TRANSFER

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- .1 Supply equipment, chemicals and components to give complete system of water treatment for various piping circuits as detailed hereinafter based on General Filtration Co. Ltd. equipment and materials.
- .2 By-Pass Feeders
  1. Supply Drew By-Pass Feeders for each of following systems:
    - Heating System - Type "HV" (7.5 Litre Capacity)
    - L.T. System - Type "AV" (19 Litre Capacity)
  2. Bypass feeders shall have steel bodies complete with vent, check, isolating and drain valves.
- .3 By-Pass Filters
  - .1 Provide Drew Model 3 CMC (3 Cartridge Type) in L.T. and heating Systems.
  - .2 Filters shall be steel bodied, contain three 10" filter cartridges, be suitable for 150# service and flow rates of 20 to 115 litres per minute. Supply carton of 30 Filter Cartridges, Type R50A10T.
- .4 Supply following chemicals in addition to those used for cleaning systems:
  - .1 Cleaner - for each Recirculating Water System, two 23 Litre Pails Ferroquest 345 (total of 4 pails).
  - .2 Chemical for Closed Systems
    - Five 20 litre pails DREW 545 Molybdate corrosion control.
    - Type 'S' Test Cabinet with light and lock.
    - Nitrite Test Kit (#2508)
      - Organic Test Kit (#920)
      - "P", "M" and "C1" Test Kit (#2551)
- .5 Alternate Equipment
  1. Rochester Midland Corp.
  2. WME
  3. Guardian Chemicals
  4. Glengarry Chemicals

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LIQUID HEAT TRANSFER

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**2.19 HEAT PUMPS**

- .1 Heat Pump Units shall be Climate Master Heat Pumps reverse cycle package heating/air conditioners of models shown on the drawings suitable for ground source application using Loopanol-2 as a thermal fluid. Types, sizes and performances are shown in Heat Pump Unit Schedule. Each H.P.U. shall be U.L. and C.S.A. listed and performance certified by A.R.I. CSA certification shall not be invalidated by inclusion of options noted in this Specification. Heat pumps shall meet or exceed A.S.H.R.A.E 90.1 requirements.
- .2 Units shall be supplied completely factory built and capable of operation with an entering water temperature range from 20° to 120°F (-6.7° to 49°C) as standard. All equipment listed in this section must be rated and certified in accordance with ARI/ISO, NRTL or CSA. The units shall have ARI/ISO, NRTL or CSA labels. All units shall be factory run tested under normal operating conditions at nominal water flow rates. This testing shall generate a report card to be shipped with each unit stating performance in both heating and cooling modes. Serial numbers will be recorded by factory and furnished to contractor for ease of unit warranty status. Units tested without water flow ARE NOT acceptable.
- .3 Each H.P. Unit shall contain sealed refrigerant circuit (HFC 410A refrigerant) consisting of field replaceable hermetic motor-compressor, air-to-refrigerant finned tube heat exchanger (for water to air type and water to refrigerant for water to water type), capillary expansion tube, pilot operated refrigerant reversing valve, solenoid valve, water-to- refrigerant coaxial tube heat exchanger, high pressure and low temperature safety cut-outs, motor and filter section with filters. Integral control section shall include all operating and safety controls.
- .4 Each H.P. unit shall be complete with factory mounted automatic flow regulator and water solenoid valve.
- .5 Ceiling mounted models shall be horizontal configuration with horizontal air discharge and return complete with rubber-in-shear isolators. Units shall be built for filter removal in any of three directions.
- .6 Horizontal Units shall have one of the following air flow arrangements: Right-Discharge/Left-Inlet; Left-Discharge/Right-Inlet; Back-Discharge/Left-Inlet; or Back-Discharge/Right-Inlet as shown on the plans. Units must have the ability to be field convertible from side to back or back to side discharge with no additional parts or unit structure modification. Units will have factory installed hanger brackets and isolation grommets. Units will also have factory installed 1" duct collars.

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LIQUID HEAT TRANSFER

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- .7 All units must have a minimum of three access panels for serviceability of compressor compartment. If other arrangements make servicing difficult, the contractor must provide access panels and clear routes to ease service. Architect must approve any changes in layout.
- .8 The horizontal heat pumps shall be fabricated from heavy gauge galvanized sheet metal. All interior surfaces shall be lined with 13 mm thick, 0.67 kgs. acoustic type glass fiber insulation. All fiberglass shall be coated and have exposed edges tucked under flanges to prevent the introduction of glass fibers into the air stream. All insulation must meet NFPA 90A.
- .9 UltraQuiet package shall consist of high technology sound attenuating materials that are strategically applied to the cabinet, in addition to the standard ClimaQuiet system, to further dampen sound.
- .10 Each unit shall be supplied with two flexible metallic hose assemblies for supply and return piping. Each unit shall be supplied with 900 mm long flexible metallic condensate hose assembly of adequate size to accommodate any condensate generated.
- .11 All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream ARE NOT acceptable. Units shall have a factory installed 1 inch wide filter bracket for filter removal from either side. Units shall have a 1 inch thick pleated filter. The contractor shall purchase one spare set of filters and replace factory shipped filters on completion of start-up. Filters shall be standard sizes. If units utilize non-standard filter sizes then the contractor shall provide 4 spare filters for each unit.
- .12 Cabinets shall have separate openings and knockouts for entrance of line voltage and low voltage control wiring. Supply and return water connections shall be copper FPT fittings and shall be securely mounted flush to the cabinet corner post allowing for connection to a flexible hose without the use of a back-up wrench. Water connections that protrude through the cabinet or require the use of a backup wrench SHALL NOT be allowed. All water connections and electrical knockouts must be in the compressor compartment corner post as to not interfere with the serviceability of unit. Contractor shall be responsible for any extra costs involved in the installation of units that do not have this feature. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

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LIQUID HEAT TRANSFER

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- .13 Units rated 5 ton and under shall have a direct-drive centrifugal fan. The fan motor shall be 3-speed, permanently lubricated, ECM type with internal thermal overload protection. Blower shall have inlet rings to allow removal of wheel and motor from one side without removing housing. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor shall be isolated from the fan housing by torsionally flexible isolation grommets. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. CFM/Static pressure rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil and/or no filter SHALL NOT be acceptable.
- .14 Units shall have a sealed refrigerant circuit including a high efficient scroll, rotary or reciprocating compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, a reversing valve, a coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, a low pressure sensor, and a low water and low air temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a lockout device. The lockout shall be reset at the thermostat or at the contractor supplied disconnect switch. Units which may be reset only at the disconnect switch only SHALL NOT be acceptable.
- .15 The compressor will be mounted on external computer selected isolating springs. The external springs will be secured to rails that are isolated from the cabinet base. Compressor shall have thermal overload protection and be located in an insulated compartment away from air stream to minimize sound transmission. Refrigerant to air heat exchangers shall utilize enhanced lanced aluminum fins and rifled copper tube construction rated to withstand 450 PSIG refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 450 PSIG working refrigerant pressure and 450 PSIG working water pressure. Plate to plate heat exchangers ARE NOT acceptable.
- .16 Refrigerant metering shall be accomplished by thermostatic expansion valve only. Units intended for use in factory standard built operating range with entering water temperatures from 20° to 120°F (-6.7° to 49°C). Reversing valves shall be four-way solenoid activated refrigerant valves which shall fail to heating operation should the solenoid fail to function. If the reversing valve solenoid fails to cooling, a low temperature thermostat must be provided to prevent over-cooling an already cold room.

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LIQUID HEAT TRANSFER

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- .17 Automatic reset freeze protection shall be provided within each unit to directly protect water coil from freezing using device that will not cause nuisance shut-down because of cold ambient air temperature. Freezestat shall be set at 4°C to provide safe margin against damaging freeze and be in direct contact with circulating water. Indirect sensor is not acceptable and must be modified to ensure direct sensing of leaving water temperature.
- .18 The drain pan shall be constructed to inhibit corrosion and fully insulated. Drain outlet shall be located on pan as to allow complete and unobstructed drainage of condensate. Vertical units will be supplied with factory installed trap inside of cabinet. The unit as standard will be supplied with solid-state electronic condensate overflow protection. Mechanical float switches WILL NOT be accepted.
- .19 Each unit water-to-refrigerant heat exchanger shall incorporate serpentine water coil which will not trap air and be suitable for 200 kpa water circuit design pressure.
- .20 Where units supplied exceed electrical load requirements indicated, supplier shall ensure that all electrical devices such as disconnects, circuit breakers, and wiring are adequately sized to accommodate these loads. Advise Consultant of such changes for their review as part of Shop Drawing processing.
- .21 Where units supplied exceed water pressure drops indicated, supplier shall ensure that all piping, circulating pumps, and other associated equipment is adequately sized to accommodate these pressure drops, as well as any changes to pump motors and associated electrical hardware. Advise Consultant of such changes for their review as part of Shop Drawing processing.
- .22 Each unit shall have extended 4 year Parts and Labour Warranty on complete hermetic refrigeration circuit, F.O.B. suppliers local service centre. This warranty shall include compressor, refrigerant tubing, reversing valve, air coil, and water-to-refrigerant heat exchanger.
- .23 Coefficients of performance (C.O.P.) and energy efficiency ratios (E.E.R.) shown in Schedule are minimum acceptable.



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LIQUID HEAT TRANSFER

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- .24 Alternate Equipment:  
(Include for all electrical revisions necessary to suit equipment including wire sizes, breakers, etc. to suit power supply).
1. Florida
  2. Daiken
  3. Water Furnace
  4. Johnson Controls
  5. Trane
  6. Carrier

**2.20 VARIABLE FREQUENCY DRIVE**

- .1 Provide variable frequency drives for two (2) pumps. One pump is standby for the other pumps. Verify horsepower of existing equipment prior to order VFD's.
- .2 Furnish complete ABB ACH550 BACnet variable frequency drives as specified herein for supply air unit fan. All standard and optional features shall be included within the VFD's enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure.
- .3 The VFD's shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to negate the need for motor derating.
- .4 An advanced sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life.
- .5 The VFD's shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- .6 The VFD's and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option panel, in the case where these are not contained in one panel. When these drives are to be located in Canada, the CSA or C-UL certifications shall apply.

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LIQUID HEAT TRANSFER

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- .7 The VFD's shall have a DC link reactor to minimize power line harmonics. VFDs without a DC link reactor shall provide a 3% impedance line reactor.
- .8 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- .9 The VFD's shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.
- .10 An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide a 3% to 10% additional energy savings.
- .11 Input and output power circuit switching can be done without interlocks or damage to the VFD's.
- .12 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.
- .13 Protective Features
  - 1. Class 20 I2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications.
  - 2. Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD's shall display all faults in plain English. Codes are not acceptable.
  - 3. Protect VFD's from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 150 volts for 208/230 volt units, and 285 volts for 460 volt units.
  - 4. The VFD's shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
  - 5. Drive shall have semi-conductor rated input fuses to protect power components.
  - 6. Drive shall include a "signal loss detection" circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.
  - 7. Drive shall be designed and constructed so that input or outputs can be disconnected with the drive running without the need for interlocks.

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LIQUID HEAT TRANSFER

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8. Drive shall catch a rotating motor operating forward or reverse up to full speed.
9. VFD's shall be rated for 100,000 amp interrupting capacity (AIC).
10. Drive shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD's will identify which of the output phases is low or lost.
11. Drive shall continue to operate without faulting until input voltage exceeds 300 volts on 208/230 volt drives, and 604 volts on 460 volt drives.

.14 Interface Features

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

#### LIQUID HEAT TRANSFER

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16. Floating point control interface shall be provided to increase/decrease speed in response to switch closures.
17. Sleep mode shall be provided to automatically stop the drive when speed drops below set "sleep" level for a specified time. Drive automatically restarts when speed command exceeds set "wake" level.
18. Run permissive circuit shall be provided to accept a "system ready" signal to assure that the drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation.
19. An elapsed time meter and kWh meter shall be provided.
20. The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature in degrees, and Motor Speed in engineering units per application (in percent speed, GPM, CFM). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
21. Up to four meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive's response to that signal for ease in commissioning.
22. Drive will sense the loss of load and signal a no load/broken belt warning or fault.
23. The VFD's shall have temperature controlled cooling fans for quiet operation and minimized losses.
24. The VFD's shall store in memory the last 20 faults and record all operational data.
25. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
26. Two programmable relay outputs, one Form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.
27. Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 V dc, 0-20 mA and 4-20 mA.
28. Two programmable analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.
29. Under fire mode conditions the VFD's shall automatically default to a preset speed.

.15 Adjustments

1. VFD shall have an adjustable carrier frequency.
2. Sixteen preset speeds shall be provided.

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LIQUID HEAT TRANSFER

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3. Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping.
4. Four current limit settings shall be provided.
5. If the VFD's trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit, inverter overload and motor overload.
6. The number of restart attempts shall be selectable from 0 through 20 and the time between attempts shall be adjustable from 0 through 600 seconds.
7. An automatic "on delay" may be selected from 0 to 120 seconds.

.16 Bypass

1. Provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in DRIVE or BYPASS mode in case of an external safety fault.

.17 Service Conditions

1. Ambient temperature, -10 to 40°C (14 to 104°F).  
0 to 95% relative humidity, non-condensing.
2. Elevation to 3,300 feet without derating.
3. AC line voltage variation, -10 to +10% of nominal with full output.
4. No side clearance shall be required for cooling of any NEMA 1 units, or of any NEMA 12 units of less than 75 HP at 460 volts. All power and control wiring shall be done from the bottom.

.18 Quality Assurance

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

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LIQUID HEAT TRANSFER

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.19 Submittals

1. Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalog information.
2. The specification lists the minimum VFD's performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.
3. Submit a Harmonic Distortion Analysis for the jobsite location.

.20 Alternate:

1. Graham
2. Emerson
3. Danfoss

**PART 3 - EXECUTION**

**3.1 PIPING TESTS**

- .1 In addition to tests required by local authorities, test new piping and drains in presence of Consultant as hereinafter described.
- .2 Notify Consultant in writing at least 48 hours prior to start of tests. Failure to do so may require test to be redone.
- .3 Fill hot water heating (H.T.) piping system with cold water and pressure test at 700 kPa for not less than twenty-four hours without decrease in pressure.
- .4 Perform tests before application of pipe covering. Test concealed piping before concealing in structure. Protect equipment and materials not capable of withstanding test pressure during tests.
- .5 Make leaks tight while systems are still under test. If this is impossible, remove and refit defective parts. Caulking of threaded joints or welds will not be permitted.
- .6 After final tests have been completed obtain a letter from General Contractor that there will be no more drilling in areas where pipes are buried or covered with concrete. It is the responsibility of this Division to mark buried pipe runs where drilling will take place after covering the pipes.
- .7 After leaks have been repaired, repeat tests as often as necessary to ensure tightness of each system.

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LIQUID HEAT TRANSFER

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**3.2 PIPE & FITTINGS**

- .1 Provide new pipe and fittings free from rust and scale of full weight, standard size and thickness, true and round with full cut threads. Ream and file ends of pipe and remove burrs from interior. Make screwed joints iron to iron or with filler of graphite, lead and oil. Hemp or paste shall not be used. Use reducing fittings instead of bushings wherever reductions in piping occur. Bullhead tees will not be permitted.
- .2 Make reductions in hot water system piping so that air cannot collect in piping except at air vents.
- .3 Weld all piping 63 mm size and larger throughout except where unions or flanges are used. Weld all buried piping without exception. Weld all condensate piping except where union or flanges are used.
- .4 Provide flanges or unions at connections to equipment, radiation and coils so same can be disconnected for service or replacement.
- .5 Support piping independently of equipment to permit disconnection and removal without disruption of piping system. Locate valves, unions and flanges to permit easy removal of coils and equipment with minimum removal of piping.
- .6 Where air handling units have multiple water coil sections, coils shall be reverse return piped to act as single balanced flow unit.
- .7 Piping, valves, strainers, unions, flanges, etc. on connections to equipment such as pumps, coils, control valves, etc. shall be full line using reducer couplings at inlet and outlet to unit size.

**3.3 WELDING**

- .1 Welding shall conform to CSCA #W-47 and amendments to date. Welders shall be licensed and certified for type of welding used. Either gas or electric welding may be used but in both cases, suitable fire protection shall be readily available.

**3.4 VALVES**

- .1 Provide on piping to and from each item of equipment (boiler, pump, manifold) necessary shut-off valves full size of line for isolating same on system side of unions or flanges.

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LIQUID HEAT TRANSFER

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**3.5 EXPANSION PROVISIONS**

- .1 Install piping to allow for expansion and contraction to approval. Provide swing joints and spring pieces at connections to mains, risers, coils and equipment.
- .2 Provide anchors, pipe guides, expansion loops and joints where shown or required to approval. Fittings for expansion loops shall be welded.

**3.6 PIPE GRADING**

- .1 Grade H.T. heating piping 'UP' in 1:240 to air vents. Arrange piping to ensure minimum number of vents. Provide scale pockets at low points and where specifically shown.

**3.7 SYSTEM VENTING**

- .1 Provide coin type air vent at each high point in piping of heat pump units. Concealed vents shall have 500 mm minimum flexible metal tubing and be brought out flush with panel front, end, wall or ceiling.
- .2 Provide 19 mm x 100 mm long air pocket for each vent. Point drain outlet of vents down. Provide access panels for concealed vents. Note: Do not install vents in removable access panels. Install vents in lift out ceilings secured to T-bar frame so lift out panels may be removed without disturbing vent. Pipe drain outlet of automatic air vents to safe disposal point.

**3.8 DRAIN VALVES**

- .1 Provide 19 mm lockshield 100# steam W.P. hose cock at main low points to drain each water type system. Provide 13 mm lockshield hose cock on each water type downfed unit.
- .2 Provide 19 mm lockshield hose cock on system side of each zone shut-off and balancing valve. Locate as directed on site to permit each zone to be drained.
- .3 Pipe outlets of relief valves, boiler and equipment drains and valves full size to end approximately 50 mm above Funnel Floor Drains left by Plumbing Section #15400. Pipe each outlet individually.

**3.9 AIR SEPARATOR**

- .1 Install air separators in piping and pipe to cushion tanks. Install specifal auto vent on outlet.



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LIQUID HEAT TRANSFER

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- .2 Installation shall comply with separator and tank manufacturers printed directions.
- .3 Install air separator in under floor heating loop.

**3.10 EXPANSION TANK**

- .1 Hang tank from building structure.

**3.11 WATER TREATMENT EQUIPMENT**

- .1 Service
  - .1 Treatment supplier shall include for "total" supervision of system cleaning and flushing, one day start-up, and four additional calls. A written report to Owner and Engineer covering details of this supervision, and system operation and control will be required following each call.
  - .2 Two complete sets of instructions, control charts and record books shall be supplied to Owner by water treatment supplier.
  - .3 Supplier will instruct building's operating personnel before acceptance of installation by Consultant.
  - .4 One well has been provided. Include this well as part of the work.

**3.12 CLEANING & FLUSHING SYSTEMS**

- .1 On completion, clean complete under floor heating system using Ferroquest 345 or equal cleaner for at least eight hours at 37.8°C. Flush out each system, opening and cleaning each scale pocket and strainer. System must be flushed out before filling with clean water.
- .2 If in-line circulators are used during cleaning and flushing, provide new seals on same afterwards. Ensure flushing line on base mounted pump seals are operating during cleaning flushing, when pumps are on. Division 23 shall replace all pump seals which become defective during the one year guarantee period, at NO COST to Owner.
- .3 During cleaning operation, heat pump units shall be disconnected and their hose connections used to bypass water around each unit. Operate heating boilers to maintain 30°C system water temperature in systems. DO NOT EXCEED 43°C. See heat pump manufacturers printed instructions for further information and guidance.
- .4 The supplier of the chemical treatment equipment and chemicals will supervise the entire cleaning and flushing operation of all the systems.

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#### LIQUID HEAT TRANSFER

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- .5 The supplier shall ensure the following:
  - .1 All systems are flushed of all sand, gravel and filings before cleaner is added.
  - .2 The proper strength of cleaner is added and circulated for the prescribed time.
  - .3 Each system is thoroughly flushed again before chemicals are added.
  - .4 The proper dosage of chemicals is added.
  - .5 Cartridge filters are replaced at the proper intervals.
- .6 Provide written report to Consultant when cleaning is completed. Advise Consultant and Owner at least 48 hours prior to cleanout so same can be witnessed.

### **3.13 WATER PUMPS**

- .1 Provide S.A. Armstrong Ltd. water circulating pumps of sizes, types and capacities noted in Pump Schedule with impeller statically and dynamically balanced at factory. Each pump shall be factory tested and guaranteed to give required performance on proposed service.
- .2 Provide line size (not pump inlet size) shut-off ball valve and strainer ahead of each pipe mounted pump and check valve and shut-off valve on each discharge.
- .3 Arrange piping to give at least five pipe diameters of straight pipe on inlet and outlet of each base mounted pump.

### **3.14 FLOW MEASURING EQUIPMENT**

- .1 Provide in discharge of each manifold, convector, unit heater and circulating pump and a S.A. Armstrong circuit balancing valve to suit pipe size. Also provide similar valves where shown on return piping system.

### **3.15 STRAINERS**

- .1 Provide strainers ahead of each pump.
- .2 Install strainers so that screen outlet is pointed down and retained debris will fall out by gravity into a container. Provide full plug size ball valve on each pump strainer outlet for blowdown with 150 mm long nipple extension with hose end.

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LIQUID HEAT TRANSFER

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**3.16 THERMOMETERS & GAUGES**

- .1 In addition to any thermometers shown or specified elsewhere, provide thermometers on supply and return of floor heating zone piping circuit adjacent to zone shut-off and balancing valves.

**3.17 EARTH LOOP THERMAL FLUID**

- .1 System MUST be cleaned BEFORE filling, by circulating a 1/4% solution by weight of tripotassium phosphate or trisodium phosphate for at least 4 hours at 50C (40oF) and then drained and flushed with clean water meeting above criteria. Consult with quatic regarding method of cleaning.
- .2 Install two (2) 19 mm valved capped hose end connection in this system for charging system across system pumps and clearly identify both connections as to use.
- .3 Circulate solution in system for at least 48 hours and verify solution characteristics before starting system. Report actual characteristics and lowest safe operating temperature and guarantee same in writing to Architect.
- .4 On completion of work, supply at least one (1) 45 Imperial Gallon (205 litre) drums of premixed solution for topping up system complete with instructions. Drums shall be suitably labeled to show contents. Supply similar empty drum, also labeled for containing solution taken from system complete with bung plugs, etc.
- .5 System shall be purged of all air during and after filling with solution. After one (1) week of operation, repurge system and verify system is 100% full, no air is present and system pressure remains constant at approximately 30 psig (208 kPa) at pumps under no flow condition.

**3.18 BURIED EARTHLOOP PIPING**

- .1 Clean and flush each earthloop after pressure testing to hold 700 kPa (100 psig) for 24 hours without decrease in pressure. Each pipe loop shall be pressure tested before being layed into trench. Repeat cleaning, flushing and pressure testing after pipe circuit is connected to pipe headers. All earth loop piping circuits shall be left clean and filled with clean water before charging with solution.

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LIQUID HEAT TRANSFER

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- .2 Flush and purge system of debris and air as outlined in CEEA Engineering Manual, Chapter 7. Also see CAN/CSA #C445-M89 and comply thereto. Fill system including interior piping, circulate and reflush and repurge to ensure complete system is clean and free of air.
- .3 Provide written report confirming that all system piping has been cleaned, flushed and pressure tested as per plans and specifications. Co-ordinate with interior piping installer.
- .4 Excavating Subcontractor shall dispose of waters used in excavating or recovered from trenches in safe manner to local and MOE requirements. Such water shall NOT be permitted to flow onto adjacent or municipal properties.
- .5 Supply summary of final pressure readings for all loops and systems at completion of work, AND 12 months into guaranty period.
- .6 Provide glass framed chart showing borehole field with each hole numbered, each supply and return pipe circuit numbered and tagged. Indicate the number of each bore hole connected to each circuit.
- .7 Provide minimum two trace circuits wires to assist in future identification of horizontal pipes in the field. Wires shall be 14 gauge solid copper insulated with TW or equivalent material. Each circuit must be wired from Pump Room out to field in trenches and back in Pump Room. Divide field into two equal areas. Wires shall be CSA approved. Each circuit shall be clearly labelled identified and marked on as built drawings.
- .8 Refer also to report on soil conditions by Geotechnical Consultant. Include all necessary costs in tender price to accommodate and include all conditions shown in reports.
- .9 Test Well
  1. Drill the first well as a pilot test
  2. During drilling, record the different soils encountered to provide a summary of the stratigraphy along with its respective accurate depths for an independent Hydro geologist to review later.
  3. Follow materials and procedures, CSA 448.1-02 and CSA 448.2-02 Standards and procedures shall apply.
  4. After the well has been drilled, insert a (2 tubes 1.25" diameter each with 'U' bend) geothermal closed loop down to 125 meter level.
  5. Immediately after insertion, tremie grout (pressure grout from the bottom up) with either a 20% solid bentonite blend or a 5% bentonite with 95% cement.
  6. Pressure test the well to a 100 PSI level to hold for 12 hours.

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#### LIQUID HEAT TRANSFER

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7. Flow test the well to assure that there is no restriction that occurred during installation.
- .10 Thermal Response Test
  1. Supply and install a Thermal Response Test Machine.
  2. Assure you have continuous power for a minimum of 48 hours.
  3. Record the conductivity of the borehole.
  4. Record the diffusivity of the borehole.
  5. Produce a complete and graphed report for the above tests and drilling.

### 3.19 HEAT PUMPS

- .1 Division 26 will provide power wiring to each heat pump unit. Division 25 to provide all controls wiring for heat pump units and tie Bacnet interface cards on units to BMS. Startup and configuration of heat pump units and Bacnet interface
- .2 Supply services of factory trained installation representative for at least two site visits during construction period for supervision of system installation, checking and testing of each individual heat pump unit, and start-up and commissioning of entire system complete with operating controls to Owner or his representatives.
- .3 After connection of heat pumps into low temperature (L.T.) water loop, water flow balance shall be conducted to assure proper flow rate to each heat pump. This procedure must be supervised by heat pump manufacturer's factory trained personnel.
- .4 Install each suspended unit in place with steel rods from building structure using inserts provided in place by this Section. Installation shall comply with manufacturers directions and be approved by Consultant. Supply spring type anti-vibration mount at each support point. Hangers and isolators shall not extend below bottom of unit when ceiling mounted. Mount vertical units on 100 mm concrete housekeeping pads. In addition, mount counter flow units on steel stands.
- .5 Co-operate with Sheet Metal Trade to install ductwork for each unit as shown via flexible connectors.
- .6 Pipe each unit into L.T. loop complete with unions at connection. Install ball valves and hoses to approval. Piping shall conform to manufacturers printed directions. Note requirements for flushing piping system.
- .7 Each unit condensate hose shall be coiled by installer to provide minimum 75 mm trap and be connected to condensate disposal system so that all condensate piping is pitched downward from unit.

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LIQUID HEAT TRANSFER

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- .8 Start-up each unit, test and adjust controls and components and put each unit and each entire system in safe efficient operating condition to meet design criteria and manufacturer's directions.
- .9 Training
  - 1. Provide training for the Owner's personnel on the operation and maintenance of the Heat Pumps.

**3.20 VARIABLE FREQUENCY DRIVES**

- .1 Install VFD's in Mechanical Room.
- .2 Wire between VFD's and pumps.

**3.21 OPERATE & ADJUST SYSTEMS**

- .1 Operate all systems to full capacity and verify proper, safe efficient operation of all parts and each complete system. Oil motors and grease bearings before operating equipment.
- .2 Turn over to Owner, necessary keys, handles and operating devices for each system.
- .3 When work is complete and systems are in operation, adjust valves, belt drives, controls, valves, dampers and thermostats so that there is even distribution of cooling, heating and air and water throughout. Turn over to Owner, necessary keys, handles and operating devices for each system.
- .4 Mechanical Contractor shall employ and cooperate with Balance/Test Company and supply sufficient manpower, tools, scaffolds, ladders, etc., to enable each system to be suitably tested and adjusted to give required performance. Balance all water systems to obtain flows specified. Provide test/balance reports on all items.

Locate all necessary access doors, system thermometers, pressure gauges, flow taps and valves shown or specified in proper locations to direction of Balance/Test Company. Note that tradesmen must be supplied to properly assist work of balancing company, including assistance required to remove ceiling tiles, guards or access doors, whatever is necessary for testing and placing them back when work is finished.

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LIQUID HEAT TRANSFER

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- .5 It is responsibility of each trade to adjust equipment, valves, splitters, dampers, controls, drives and speeds necessary to put each system into its proper design operating condition to direction of Balance/Test Company. Each system shall be within 5% of design figures.

**3.22 QUIET OPERATION**

- .1 Each system has been designed to be quiet in operation. It is responsibility of this Section to supply equipment and install systems to ensure noise levels will be maintained satisfactory to Consultant.

**3.23 WARRANTY**

- .1 Furnish to Owner through General Contractor and Architect, written warranty covering materials and workmanship and free service for one year from date of start of lien period.
- .2 Warrant apparatus installed to properly cool, heat and ventilate without undue noise through every item of equipment and system and to maintain reassured room conditions.
- .3 Warranty shall entail repair or replacement of materials installed without change to Owner except where, in opinion of Architect, such repair or replacement was caused by improper use or lack of proper maintenance.

END OF SECTION

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AIR DISTRIBUTION

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
-------------------	--------------

PART 1 - GENERAL

1.1	Related Instructions
1.2	Work Included
1.3	Submittals

PART 2 - PRODUCTS

2.1	Materials
2.2	Standard Ductwork
2.3	Fire Dampers
2.4	Pressure Regulators
2.5	Grilles, Registers & Diffusers
2.6	Fixed Louvres
2.7	Heat Recovery Unit
2.8	Fan Equipment
2.9	Carbon Monoxide and NOx Detection System
2.10	Electric Duct Coils
2.11	Tailpipe Exhaust System
2.12	DX Fan Coil Units
2.13	DX Air Cooled Condensing Unit
2.14	Steam Humidifier

PART 3 - EXECUTION

3.1	Standard Ductwork
3.2	Fire Dampers
3.3	Fixed Louvres
3.4	Fan Equipment
3.5	Heat Recovery Unit
3.6	Electric Duct Coils
3.7	Tailpipe Exhaust System
3.8	Carbon Monoxide & NOx Monitoring System
3.9	Steam Humidifier
3.10	Operate and Adjust Systems
3.11	Quiet Operation



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AIR DISTRIBUTION

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**PART 1 - GENERAL**

**1.1 RELATED INSTRUCTIONS**

- .1 Comply with requirements of Section 21 05 01, Mechanical General Requirements.

**1.2 WORK INCLUDED**

- .1 Work under this contract shall include, but is not limited to, the following:
- .2 Supply and installation of each supply and exhaust system shown on Drawings including fan, ductwork and back-draft damper.
- .3 Supply and installation of supply/return air duct systems for heat pump units with accessories to complete each system.
- .4 Supply and installation of all grilles, registers, diffusers, fire dampers, fire flaps and accessories for all duct systems.
- .5 Installation of motorized dampers and control devices.
- .6 Supply and installation of duct acoustic liner in all ducts as specified.
- .7 Supply and installation of all components, accessories and incidentals necessary to complete each system and put same in safe, efficient operation.
- .8 Supply and installation of HRU unit and Exhaust Systems.

**1.3 SUBMITTALS**

- .1 Submit Shop Drawings for following:
  - 1. Fan equipment and accessories.
  - 2. Grilles, registers, diffusers and accessories.
  - 3. Fire dampers and fire stop flaps.
  - 4. Louvres
  - 5. Heat Recovery Unit
  - 6. Carbon Monoxide and NOX Detection System
  - 7. Electric Duct Coils
  - 8. Rail Pipe Exhaust System
  - 9. Steam Humidifier

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AIR DISTRIBUTION

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**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- .1 Materials shall be of Canadian manufacture where available, of best quality of their respective kinds and of uniform pattern throughout.

**2.2 STANDARD DUCTWORK**

- .1 ALL DUCTS and duct systems must comply with and be constructed in accordance with ALL applicable codes and regulations, whether shown or not.
- .2 Ducts shall be made of first quality smooth finished, cold rolled galvanized steel guaranteed to double seam without fracturing of thicknesses noted, AND of aluminum in all pool area ducts as listed under Part 3 - Execution.
- .3 Round ducts exposed to view shall be Alpha Industries Ltd., Mississauga or equal "Multi-Rib" 0.478 mm satin coat galvanized steel spiral lock seam duct with "ASM" preformed fittings.
- .4 Balancing damper operators shall be lockable quadrant type Duro Dyne #KS-195L. Splitter damper operators shall be Duro Dyne #SRP24/SRP40 rod-operators.
- .5 Duct sealant shall be Multi-Purpose Air Duct sealant, U.L.C. labeled, as provided by Trans Continental Equipment, Concord or Flexmaster Duct Bond II (Richmond Hill).
- .6 Access doors shall be assembled with Duro Dyne SP-21 latch assembly, HP series piano hinges and GN neoprene closed cell gasket material.
- .7 Pitot tube opening enclosures shall be Dial #1000 or 2000 (Air Power Equipment, Toronto).
- .8 Air turning assembly shall be double thickness type with Duro Dyne #VR-2 vane rails.
- .9 Duct tape shall be Duro Dyne GS, 50 mm wide self adhesive duct tape.
- .10 Acoustic duct liner shall be 25 mm thick Fiberglas or equal rigid coated duct liner of 4-1/2# density with flame spread rating of 25, fuel contributed rating of 15 and smoke developed rating of 40 with Neoprene face coating.

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AIR DISTRIBUTION

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- .11 Provide 25 mm thick acoustic duct liner in all supply, return and mixed air ducts of fan coil units and split system units
- .12 Flexible duct shall be preinsulated Trans-Continental Equipment Ltd. type 'SI' Al-U-Flex aluminum or Thermoflex M.KC glass fibre flexible air duct hoses each U.L.C. listed. Hoses must be aluminium on all aluminium duct systems.
- .13 Concealed operators for each splitter or balancing damper above fixed ceiling shall be Duro Dyne #SRC complete with extension rod, coupling and dial operators.
- .14 Flexible connections shall be 813.7 g/m<sup>2</sup> Durolon coated glass fabric.

**2.3 FIRE DAMPERS**

- .1 Fire Dampers in ducts through floors and walls shall conform to Ontario Building Code, Subsection 3.1.8. Fire Stop Flaps in ceiling diffusers, registers and grilles shall conform to Ontario Building Code, Subsection 3.1.8 and must be built to U.L.C. Standards and be approved by local Building Department. Submit Shop Drawings for review. No asbestos shall be used.
- .2 Fire Dampers shall have 1-1/2 hour fire protection rating in accordance with NFPA #252, bear U.L.C. label and be tested in accordance with U.L.C. Standard #S-112. Hinged blade Fire Dampers shall close in direction of airflow. Fire Dampers in Fire Walls or fire separations of 2 hour or more rating shall conform to U.L.C. #S-104 for 3 hour rating.
- .3 Fire Dampers behind grilles or in standard ductwork shall not decrease duct free area more than 10% in open position. Enlarge ducts or use Type B (recessed shutter) as necessary to meet this condition. Also where shown, provide Type 'B' (recessed shutter) Fire Damper to give 100% free area for noise and turbulence control.
- .4 Fire Dampers in round ductwork shall not decrease duct free area under any circumstance. Provide Type 'C' (100% free area recessed shutter) Fire Damper to meet this condition.
- .5 Fire Stop Flaps shall be made to suit U.L.C. rated floor/ceiling and roof/ceiling assemblies specified.
- .6 Fire Stop Flaps shall be Controlled Air Mfg. Ltd. #CFS or Nailor Hart Fire Stop Flap with ceramic fabric built to suit U.L.C. rated floor/ceiling and roof/ceiling assemblies specified. Fire Stop Flaps shall be U.L.C. labeled.

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**AIR DISTRIBUTION**

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- .7 Fire Dampers in drywall or at ceilings (not F.S.F.) shall be Controlled Air Manufacturing Ltd. #CFS or CFSR or equal ceiling damper.
- .8 Fire Dampers under floor linear grilles shall be "slim line".
- .9 Alternates:
  - 1. Ruskin
  - 2. Nailor
  - 3. Control Air

**2.4 PRESSURE REGULATORS**

- .1 Pressure regulators shall be Fisher Controls single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator and atmospheric vent.
- .2 NPS 2 and smaller: Threaded ends according to ASME B1.20.1 for pipe threads
- .3 NPS 2-1/2 and larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
- .4 Line Pressure Regulators: ANSI Z21.80 with 5-psig minimum inlet pressure rating.
- .5 Appliance pressure regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
- .6 Pressure regulator vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.
- .7 Alternate Equipment
  - 1. Canadian Meter Company
  - 2. Schlumberger
  - 3. National Meter Industries Inc.

**2.5 GRILLES, REGISTERS & DIFFUSERS**

- .1 Provide E.H. Price Ltd. grilles, registers and diffusers of sizes and types shown conforming to and Certified Test Rated in accordance with Air Diffusion Council Equipment Test Code No. 1062R2 of latest date.

#### AIR DISTRIBUTION

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- .2 Grilles, registers and diffusers shall be of steel construction (except use aluminium throughout all aluminium duct systems, see Ductwork), with baked white enamel finish, except in walls where prime coat finish shall be supplied. Aluminum frames and bars shall be extruded from hard stock, free from pits and spots. Joints shall be 'hairline'. Attachment shall be with stainless steel or C.P. screws with 6.4 mm thick urethane sponge gasket set under flange.
- .3 Diffusers shall have white baked-on enamel finish. Diffusers shall be sized within limits of sound pressure level NC-32 curve in typical room having average attenuation of 8 DB. Each supply air diffuser shall be complete with flow equalizer and separate volume control operable from ceiling level. Supply diffusers shall be sized so that neck velocities do not exceed 4.5 m/s.
- .4 Exhaust or return air registers, except where otherwise noted, shall be #510-FSS-3, with removable key operated volume damper.
- .5 Exhaust or return air grilles in lay-in ceilings in sizes 300 x 300 mm and larger shall be #R80/BFD-0 Steel frame return air grille with aluminum eggcrate face plate, 16 mm wide margin to fit 610 mm O.C. lay-in inverted T-bar ceiling, less volume damper. Where located in ducted system, register shall have volume damper.
- .6 Ceiling space gas pipe vent grilles and pipe space grilles shall be 300 x 300 mm size, #STG-1 grilles in lay-in ceilings and #STG-1B elsewhere.
- .7 Supply air registers (except where noted) shall be #520-FSS-3 with removable key operated volume damper and shall have throw and deflection noted or required to suit room.
- .8 Air volume extractor shall be #AE-1 set in each 90 degree supply take-off where shown or where required to give efficient branch air duct performance.
- .9 Exhaust or return air grilles into ceiling spaces shall be #510FSS set on transfer duct in ceiling. Where grille size is 300 x 300 mm or larger in ceiling, provide R80/BFD grille.
- .10 Supply air registers in ceilings shall be 530 FSL-3.
- .11 Transfer door grilles will be supplied by Division 23 and installed by Section 6A.
- .12 Type A diffusers shall be #SCD-3, of steel construction and fit 610 mm O.C. T-bar suspended lay-in ceilings. Inner assembly shall be easily removable. Diffuser face shall be 610 x 610 mm size unless otherwise noted.

#### AIR DISTRIBUTION

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- .13 Type B diffusers shall be #SCD-1, style of steel construction for surface or flush mounting to ceiling. Inner assembly shall be easily adjustable for heat projection.
- .14 Type C round diffusers shall be #RCDA of aluminum construction. Inner assembly shall be easily removable of core type noted. Minimum panel diameter shall be 610 mm.
- .15 Type D linear diffusers shall be #SDS-75 with SDA75 plenum lay-in tee bar extruded aluminum, number of slots and length are shown on drawings continuous slot diffusers each complete with adjustable pattern control elements, end caps on both ends; hangers and blank-off strips as detailed and described herein. Finishes shall be baked enamel; off white on face, and black on interior parts. Provide end clip support and special frame. Return diffuser shall be similar, but less volume control provide dummy sections to give continuous appearance as shown on drawing.
- .16 Type E linear bar grille shall be Model LBP26B extruded aluminum continuous in acid etched and lacquered finish complete with opposed blade volume controller, type 271 grille frame with Type C fastening. Return grille shall be similar but less volume control. Provide dummy sections to give continuous appearance as shown on drawing.
- .17 Alternate Equipment:
  - 1. Nailor Hart Ind. Ltd.
  - 2. Titus
  - 3. Kruger
  - 4. E.H. Price

## 2.6 FIXED LOUVRES

- .1 Fixed louvres in outside walls for fan discharges or fresh air inlets shall be Airolite (E.H. Price) DEF#439, of aluminum construction with 100 mm x 2.5 mm extruded stormproof blades complete with 13 mm x 13 mm mesh aluminum birdscreen and extended aluminum sill supplied installed by this Section. Louvres shall be AMCA rated and pass required air volume at maximum 3.6 m/s at 25 Pa SP, be degreased and prime painted and have Duracon enamel finish in colour selected by Consultant.
- .2 Connect ducts to louvres so that maximum free area of louver is used and any moisture in ducts will drain out through louver. Caulking by this Section.

## AIR DISTRIBUTION

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- .3 Alternate Equipment:
1. Construction Specialties
  2. Ruskin
  3. Nailor Hart Industries Inc.
  4. Ventex

## 2.7 HEAT RECOVERY UNIT

.1 General

Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.

Substitution of any product other than that specified, must assure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.

Air handling units are to be shipped to the job in five piece. Field assembly of the shipped loose items shall be the responsibility of the installing contractor as described in the manufacturers installation instruction. All equipment shall be factory tested prior to shipment. Manufacturer shall provide a factory test proving indirect gas fired burner capable of 15:1 turndown ratio while maintaining minimum 80% efficiency throughout the range.

The Air Handling Units shall be the product of a Canadian owned firm, built in Canada, with all components made in Canada, where possible. The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.

Air Handling Units shall be manufactured by Engineered Air (905-602-4430). Alternate products must show all areas where they do not meet specified product.

Units shall consist of filter sections, return air fan section, supply air fan section, heat wheel recovery section, frost control section, indirect gas heating section, Dx cooling section, condensing section in R/A stream, gas fired humidifier in heated service vestibule, motorized dampers, control panel, temperature sensors, and all other components required for a complete packaged installation.

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AIR DISTRIBUTION

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.2 Casing

Unit casing shall be of minimum 16 (1.6mm) gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water-resistant sealant.

The following components shall be provided with a 22 gauge (.85mm) solid galvanized metal liner over insulated areas:

	Solid Liner
- Fan Sections	X
- Coil Sections	X
- Heat Recovery Sections	X
- Filter Sections	X
- All Access Sections	X

Casings shall be supported on 150mm (6") minimum structural steel channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.

Unit casing floors shall be fabricated with 14 ga checker plate steel with iron grip polyurethane coating. Provide reinforcing channels under floor to minimize deflection and prevent 'oil canning' effect.

In air-to-air heat reclaim units, the exhaust section drain pans shall be an integral part of the floor panelling, a minimum of 2" (50 mm) deep, with welded corners and coated with an asphaltic water-proofing compound. Drain pans shall extend under the condenser coil and be connected with a 1-1/2" (38 mm) M.P.T. drain connection.



## AIR DISTRIBUTION

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Outdoor air handling units shall be weatherproofed and equipped for installation outdoors. This shall include the prevention of infiltration of rain and snow into the unit, and louvres on air intakes and hoods on exhaust openings with 1" (25mm) galvanized inlet screens; rain gutters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 2" (50mm) with three break interlocking design; outer wall panels extend a minimum of 1/4 inch (6mm) below the floor panel; drain trap(s) for field installation. Provide draining louvres at fresh air intake designed to prevent penetration of moisture.

Units mounted on roof curbs incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked and tarred.

For two units, provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 18 inches (450mm) high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25mm) upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof mounting curb shall be provided by the Roofing Subcontractor.

Service Vestibule (integral) shall be insulated with 2" (50mm) thick 1½ lb./cu. ft. (24 Kg/cu. m) density acoustic insulation. Vestibule shall also be fully lined with 22 gauge (0.85mm) solid liner. Floor to be 14 gauge checker plate steel with iron grip polyurethane coating.

Access door(s) to Service Vestibule shall be complete with zinc plated piano hinges and brass pins in welded steel frames. Provide with lever lock rolling or Ventlock type handles - lockable.

Provide marine lights with Lexan globes wired in EMT to a switch with pilot light in Vestibule. Vestibule shall also be provided with a duplex service receptacle. 120v/1/60/Hz power supply off line side of main service c/w separate disconnect.

### .3 Access Doors

Units shall be provided with access doors to the following components:

- Fans and Motors
- Filters
- Dampers and Operators
- Access Plenums
- Both Sides of the Heat Recovery Wheel

## AIR DISTRIBUTION

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Access Doors shall be minimum 24"X60". Removal of screwed wall panels will not be acceptable. Provide hinged access doors, with zinc plated piano hinges and brass pins, in welded steel frames. Doors shall be fully lined with closed cell, automotive bulb gasket and lever lock roller type or Ventlock handles, operable from both sides.

Hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in.

### .4 Insulation

All units shall be internally insulated with 2" (50mm) thick 1 1/2 lb./cu.ft. (24 kg./cu.m.) density, neoprene coated fibre glass thermal insulation, secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

### .5 Filters

Filter sections shall be provided with adequately sized access doors to allow easy removal of filters.

The filters shall be lift out, from an access plenum upstream of the filters. Lift out 4" (100mm) filters shall fit into a horizontal track from which they are lifted up and out.

4" (100mm) Pleated Panel Disposable Filters: Non-woven cotton fabric media with a metal support grid and heavy duty beverage board enclosing frame. Permanent re- usable metal enclosing frame. The filter media shall have an average efficiency of 30% on ASHRAE Standard 52-76.

Provide a differential pressure switch across the filter bank to signal a dirty filter light on the remote panel.

### .6 Heat Recovery Wheel

**General:** The Total Energy Wheel shall be the sole responsibility of the Air Handling Unit manufacturer. The manufacturer shall guarantee the performance of the wheel as to its total heat transfer capability and its operation. Alternate reclaim devices shall meet or exceed the performance noted in the schedules, without exceeding the fan power requirements specified. The heat wheel shall be designed for maximum of 800 FPM using 100% of the air volume.

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#### AIR DISTRIBUTION

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**Wheel Media:** The wheel shall be constructed of sheet aluminum, with alternate layers corrugated, with adjacent layers glued to each other for stability. Wheels shall be tension wound on to a central hub. All aluminum surfaces shall be coated with a "Zeolite" aluminosilicate coating to provide water vapour transfer from one air stream to the other. Latent heat transfer shall be equal to the sensible heat transfer,  $\pm 6\%$ , throughout the complete range of operation. The wheel shall be cleanable with compressed air, or warm water without damage to the aluminum or desiccant.

**Wheel Structure:** Wheels are held securely together with extruded aluminum spokes extending radially from the hub to the peripheral aluminum banding. Spokes are flush mounted in the rotor media. Wheels of 1800 mm diameter and smaller are provided in one piece construction. Larger wheels are provided in 4 or 8 piece construction. Alternatively, the smaller wheels can also be provided in 4 piece construction.

**Wheel Seals:** Wheels shall be provided with non-contact labyrinth seals around the perimeter of the wheel, and across the face, at the division between the supply and exhaust sectors. Adjustable seals shall be spaced not more than 1 mm off the rotor surface.

**Wheel Support:** The wheel shall be supported by two pillow block bearings which in turn are supported by a tubular steel support. The bearings shall be located in the shadow of the bearing support member and the division between air streams, to maximize the free area of the rotor as much as possible. The bearings shall be replaceable without removing the wheel from the air handling unit.

**Purge System:** The unit shall be provided with a purge system to allow a percentage of outdoor air to be swept through the exhaust air sector, to eliminate the possibility of bypassing exhaust air to the supply air stream, for two reasons:

- to reduce as much as possible, the potential for contamination from the exhaust air.
- to eliminate the possibility of loss of efficiency when exhaust air bypasses to the supply air stream.

The manufacturer shall ensure that the ambient pressure at the entering air side of the exhaust sector of the wheel, is lower than the pressure at the leaving air side of the supply air sector. In the case of draw through fans, this will necessitate a field adjustable damper in the exhaust system, upstream of the total energy wheel. The manufacturer shall select the exhaust fan to provide the additional air for purge.

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## AIR DISTRIBUTION

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**Wheel Drive System:** The wheel shall be driven by a continuous V-belt around the outer perimeter of the wheel, and connected to an AC motor fitted with a gear reducer and V-belt pulley. Access to the motor and drive shall be from the side of the unit to maximize serviceability.

### .7 Fan Sections

Centrifugal fans shall be **rated in accordance with AMCA Standard Test Code**, Bulletin 210. **Fan manufacturer shall be a member of AMCA.** All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

Acceptable fan manufacturers include; **Greenheck, Twin City or Barry Blower.** All other manufacturers must be approved by Engineer prior to quoting.

Air foil fans shall be equipped with greaseable, self aligning ball type pillow block bearings. The ratio of blast area to nominal outlet area for double width fans shall be 75% or greater.

Return fan shall be air foil plenum type configuration where noted in schedules. Thrust restraint isolators shall be provided at shaft centre line when required to minimize axial movement and bending movements of the blower assembly. Drive side bearings on plenum fans shall be adapter style to ensure even clamping of the bearing sleeve to the shaft.

Drives shall be adjustable on fans with motors 5 HP (3.73 kw) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.

Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor which is welded to the structural frame of the unit. The isolators shall be vertical spring type isolators with levelling bolts, bridge bearing waffled pads with minimum 1" (25mm) static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a heavy glass fabric, neoprene impregnated, with a double locking fabric to metal connection.

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## AIR DISTRIBUTION

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Fan motors shall be rated for fan duty, open drip proof, high efficient (equal to CSA 390 M 1985) T-frame, and 575 Volt, 3 Phase, 60 Cycle.

### .8 Dampers

Provide insulated dampers equal to "T.A. Morrison series 9000". Dampers are engineered for less than 0.6% leakage 10" WG. Dampers not meeting specifications will not be acceptable. Parallel blades are 6" wide and made of aluminum extrusion and internal hollows insulated with 7/8" thick Polyurethane foam and are thermally broken. Frames are a minimum 12 Ga extruded Polystyrene foam which has an R factor of 5.0. 'Double Sealed' bearings, where a Celcon inner bearing fixed on a hexagon rod rotates within a frame. All blade linkages must be installed out of air stream in frame with steel plated hardware.

Unit shall be complete with heavy duty, automatic shut-off dampers on exhaust and fresh air side. Damper actuators to be complete with integral End Switch to prevent main fans from running until the damper has reached a sufficiently open position. Provide shut-off dampers as required to prevent cold air infiltrating building.

### .9 Indirect Gas Fired Auxiliary Heat

Heating units shall have an indirect natural gas heating section that is C-ETL, approved for both sea level and high altitude areas. The entire assembly shall be approved and labelled by a nationally recognized certification agency.

Operating natural gas pressure at unit(s) manifold shall be 7" (1750 Pa) w.c.

Gas fired units shall be approved for operation in -40°F (-40°C) locations.

Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal tubulators, and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 1" (25mm) of insulation between the outer cabinet and inner liner. Blower assemblies close coupled to duct furnace type heat exchanger are not acceptable.

Units with optional high efficiency heat exchanger shall be tested and certified to ANSI standards to provide a minimum of 80% efficiency throughout the entire operating range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.

## AIR DISTRIBUTION

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The burner assembly shall be a blow through positive pressure type with an intermittent pilot ignition system to provide a high seasonal efficiency. Flame surveillance shall be with a solid state programmed flame relay c/w flame rod. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be covered by a heat reflective galvanized steel liner. Atmospheric burners, or burners requiring power assisted venting are not acceptable.

Unit discharge air control shall include 15:1 turndown (HT burner). The high turndown burner minimum input shall be capable of controlling at 6.7% of its rated input without on-off cycling. Manufacturer shall provide a factory test proving indirect gas fired burner capable of 15:1 turndown ratio while maintaining minimum 80% efficiency throughout the range.

Installation and venting provisions must be in accordance with C.G.A. Standard B149.1, ANSI Z223.1-NFPA54, and local authorities having jurisdiction. Type A, C, and/or PS venting is required on indoor units.

### 10. Package Mechanical Cooling

Packaged cooling unit must be tested to CSA Standard C746-98(R2004) and listed with CSA Energy Efficiency Verification Program (mandatory requirement to comply with Canada's Energy Efficiency Act for packaged cooling units between 5.4 to 19.9 tons).

Coils shall be constructed of copper tube, aluminium fin, copper headers with sweat connections.

Acceptable coil manufacturers include; Engineered Air, Aerofin or Daikin. All other manufacturers must be approved by Engineer prior to quoting.

Fins constructed of aluminium shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes.

The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

Refrigerant evaporator type coil shall be equipped with minimum 3 distributors connected to the coil by copper tubes. Provide a hot gas bypass valve on lead circuit. Solenoid valves, expansion valves, and related accessories are to be installed in the factory by the unit manufacturer.

Refrigerant coil shall be designed for minimum 3 compressors and shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions. Coils shall be CSA certified.

Refrigerant shall be Type 407C.

## AIR DISTRIBUTION

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Provide a minimum of 3 hermetic type compressors, 3600 RPM, set on resilient neoprene mounts and complete with line voltage break internal overload protection, internal pressure relief valve and crankcase heater.

Remote or external condenser shall not be acceptable. The coil shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank. Coils shall be C.S.A. certified.

Unit shall also have an air stream condenser coil built to the same standards. Operation of the coil is described below (variable condenser reheat system).

Packaged units shall operate down to 50 F (10 C) as standard. Multiple refrigeration circuits shall be separate from each other. Refrigeration circuits shall be complete with liquid line filter-driers, combination sight glass moisture indicators and service ports fitted with Schraeder fittings. Units shall also incorporate load compensated thermal expansion valves with external equalizers. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.

Controls for hermetic compressor units shall include compressor contacts, supply fan contacts and overload protection control circuit transformer, cooling relays, ambient compressor lockout, high pressure controls and automatic reset low pressure controls.

- Provide five minute anti-cycle timers.
- Provide inter stage time delay timers.

### .11 Control Sequence

Heat Wheel Speed Control System:

Ambient temperature actuates ON-OFF control to facilitate a Summer-Winter changeover cycle. Unwanted heat pickup in the make-up air stream in the 55°F to 75°F ambient temperature range will be eliminated. Below the low end of the control range, auxiliary heating is enabled, above the low end of the range, auxiliary cooling is enabled.

A microprocessor based variable speed control system to provide:

- proportional temperature control of supply air
- summer-winter changeover
- frost control

## AIR DISTRIBUTION

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The variable speed control system shall consist of an AC Inverter (3 phase) c/w keypad and LED readout for programming and alarm annunciation, 16 bit microprocessor control logic, controlled speed range of 40:1, electronic motor overload protection, and ground fault protection.

All inlet and outlet dampers shall close on unit shut-down. When unit is started by Control System, fresh air and exhaust air dampers shall fully open and damper end-switches will then energize controls and start fans approx.10 seconds apart.

Electronic temperature control system with the capability control to maintain discharge temperature. The minimum run and off time for compressors shall be 4 minutes at full load startup, and may range up to 8 minutes under part load conditions. The controller shall incorporate a PI (proportional/integral) control scheme that reduces temperature drop by resetting to the set point after each stage is cycled on.

In heating range, the controller will provide a signal to the following second level device, model DJM controller for Series DJ heater as specified auxiliary heat.

Provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure this device will shut down the fan and close the outdoor air damper. This device shall require resetting by interrupting the electrical circuit.

The C-TRAC3 electronic temperature control system shall provide up to 5 stages of mechanical cooling control to maintain discharge temperature. The minimum run and off time for the compressors shall be variable based on load requirements.

The controller shall have indication and troubleshooting LED lights, multi-meter set point and sensor temperature test points, and a common alarm contact in the event of equipment failure. Information can be accessed from a PDA (personal digital assistant) or laptop computer for improved access to control settings using Engineered Air SMC software.

### .12 Unit Panel

Provide for air handling unit on unit control panel for the purpose of switching and visual indication of operations. Panel to include the following items:

- Engraved lamicaid face plate.
- System ON-OFF switch.
- System ON light.
- Cool light ON.



## AIR DISTRIBUTION

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- Heat ON light.
- Clogged filter light with unit mounted filter air pressure switch.

Factory installed and wired fused disconnect switch in CEMA 1 enclosure mounted on face of unit.

### .13 Remote Control Panel

Provide with air handling unit a remote mounted control panel for the purpose of switching and visual indication of operations. Each panel to include the following items:

- Engraved lamicoid face plate.
- System ON-OFF switch.
- System ON light.
- Heat ON light.
- Clogged filter light with unit mounted filter air pressure switch.
- Discharge set point adjustment.
- Cool ON light.

Factory installed and wired non-fused disconnect switch in CEMA 1 enclosure mounted on face of unit.

### .14 Alternate Equipment

Alternate manufacturers must ensure dimensions of their unit is no greater than the Thermal Products unit size or weight shown on drawings, BEFORE BIDDING. Contractor will be fully responsible on any changes to the base bid equipment.

1. EH Price
2. Aaon
3. Mafna

## 2.8 FAN EQUIPMENT

- .1 Fans shall be Penn Ventilators and Wilcorp as scheduled. Each fan shall be dynamically and statically balanced at factory and clearly indicate direction of rotation. Fans with forward curved wheels shall have adjustable outlet volume control. Each fan shall be A.M.C.A. rated and conform to standards of C.F.M.A. and A.S.H.R.A.E.

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AIR DISTRIBUTION

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- .2 Each fan shall have Canadian made motor for heavy duty continuous operation selected to operate equipment at maximum efficiency of KW at least equal to brake KW. Each belt drive shall be adjustable at least 20% up and down from performance shown and have 1.5 service factor. Motors shall be drip-proof ball bearing type, grease lubricated unless otherwise noted. See 21 05 01 Wiring and Motors, for further details such as start-up times. See Starter Schedule for phase and voltage conditions.
- .3 Each fan on roof shall have suitable base for mounting on roof curb and platform provided by this Section, have weather tight fastenings and integral C.S.A. approved HP rated disconnected switch mounted inside cover.
- .4 Degrease and prime paint each fan at factory and leave ready for painting by Another Section.
- .5 Each roof exhauster shall be Penn "Domex" mushroom with 'V' belt or direct drive as noted; of aluminum construction with parts exposed to weather of aluminum or stainless steel. Fan wheels shall be backward curved, non-overloading centrifugal design with permanently lubricated ball bearings. Tip speed velocity shall NOT exceed that scheduled. Motor H.P. shall be NOT less than scheduled and mounted out of air stream.  
  
Motor and fan assembly shall be on vibration isolation mounts and be quiet operating. Hood shall be 360 degree circular style easily removable to permit access to backdraft damper. Discharge outlet shall have 12 x 12 mm mesh aluminum or vinyl coated steel birdscreen rigidly secured. Each unit shall be in paintable prime coat finish as previously noted. Provide roof curb for each roof exhauster.
- .6 Provide for each fan noted in Fan Schedule, controls as noted.
- .7 Provide gravity backdraft damper on each exhaust fan. Backdraft damper shall be of multi-bladed type with aluminum blades, neoprene edged and secured. Bearings shall be corrosion resistant located inside rigidly constructed frame of heavy gauge painted steel. Blades shall be inter-connected with tie rod on inside of frame which shall be weather-stripped all round and have counter-balanced arrangement to hold blades fully open when fan is on and tightly closed when fan is off.

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AIR DISTRIBUTION

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- .8 Utility fans shall be belt drive dynamo utility fan type in AMCA Arrangement 10 with a single width, single inlet housing in CW or CCW rotation as specified. The housing shall be constructed of heavy gauge galvanized steel with lock formed seams permitting no air leakage. The housing shall be field rotatable to any of the eight standard discharge positions. Housing and bearing supports shall be constructed of welded steel members to prevent vibration and rigidly support the shaft and bearings.

The fan wheel shall be of the non-overloading backward inclined, centrifugal fan type and shall be constructed of heavy gauge steel. Wheels shall be statically and dynamically balanced. The wheel cone and fan inlet cone shall be carefully matched for maximum performance and operating efficiency. Motors shall be permanently lubricated, heavy duty ball bearing type carefully matched to the fan load and furnished at the specified voltage, phase and enclosure.

The fan shaft shall be ground and polished solid steel mounted in heavy duty, permanently sealed, pillow block ball bearings. Bearings shall be selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed, and securely attached to the wheel and motor shafts. The motor pulley shall be adjustable for final system balancing.

Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices, and fans shall be licensed to bear the AMCA Certified Ratings Seal for air performance.

- .9 Concealed cabinet fans shall be Zephyr of the centrifugal, direct drive type. The fan housing shall be constructed of heavy gauge galvanized steel and shall include prepunched mounting brackets. The housing interior shall be lined with 0.5 in. acoustical insulation. The outlet duct collar shall include an aluminum backdraft damper and shall be adaptable for horizontal or vertical discharge.

The access for wiring shall be external. The motor disconnect shall be internal and of the plug in type. The motor shall be mounted on vibration isolators. The fan wheel(s) shall be of the forward curved centrifugal type, constructed of galvanized steel and dynamically balanced.

Fans shall be licensed to bear the AMCA Certified Ratings Seals for sound and air performance and shall be U.L. Listed and C.S.A. approved.

## AIR DISTRIBUTION

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- .10 Each circulating fan shall be Wilcorp Manufacturing Ltd., Toronto, vertical downward thrust indoor type, large diameter propeller ceiling fan complete with variable speed motor, mounting brackets, canopies, 19 mm diameter downrod, 3 wire BX connections and fire cutout. Supply for each group of fans noted, WMLE-30 solid state infinite speed controller with thermostat. See Fan Schedule. See Starter Schedule.

.11 Alternate Equipment:

Roof Exhausters & Utility Fans

1. Loren Cook
2. Greenheck
3. Carnes
4. JenCo/S & P Fans
5. EFI

Concealed Cabinet Fans

1. Carnes
2. Jenn Air
3. Loren Cook
4. Broan
5. EFI

Recirculating Fans

1. Banvil

## 2.9 CARBON MONOXIDE & NOX MONITORING SYSTEM

.1 Description of Work

- .1 Provide all labour, materials, product, equipment and service to install a complete gas detection and control system as indicated on the drawings and specified in this section.
- .2 Provide and install a complete gas detection and control system where the ventilation system shall be hooked up directly to the gas detection system.  
The system standard shall be Enmet EC-Gold Dual as manufactured by Arjay Engineering/Enmet Canada Div. and as supplied by Kilmer Environmental Inc. 905 890-8908.
- .3 Provide all work as indicated on plans and diagrams.
- .4 Acceptable material Arjay/Enmet EC-Gold Dual.

.2 Reference Standards

- .1 All products shall be certified to CSA standards.
- .2 Manufacturer shall be audited and certified to ISO 9001:2008.

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AIR DISTRIBUTION

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.3 Hardware

- .1 The controller and sensor package shall be Arjay/Enmet EC-Gold Dual. The system shall be a self-contained unit with on-board control relays and sensor capability.
- .2 The unit shall include a self-diagnostic function
- .3 The unit shall be able to accommodate both CO and NO2 onboard sensors with a remote analog input sensor.
- .4 The unit shall provide three relays for common sensor alarm of Low, High and Fault. The fault relay can be re-assigned as a high/high relay if required.
- .5 A 4-20 mA output indicative of the highest, not averaged, concentration of all the sensor inputs shall be provided.
- .6 Modbus RS-485 communication shall be included.
- .7 An LCD display of the gas concentration of the sensor inputs shall be provided with common LED alarm status indication and alarm buzzer with silence button.
- .8 The unit is to be provided in a metal housing with shielded sensors and field selectable surface or rear mount conduit entry knock-outs.
- .9 The CO and NO2 sensors shall be electrochemical type
- .10 The power input shall be 24 Vdc. A separate 115 VAC/24 Vdc power supply shall be provided as required.
- .11 The control panel will leave the factory fully programmed and calibrated and shall be field adjustable via the keypad. Programming must be saved in the event of power loss.
- .12 The unit shall be designed for operation between -20 C and 40 C.
- .13 Unit shall be certified to CSA standards. The controller must be manufactured within an ISO 9001-2008 audited and certified production environment.
- .14 All controller hardware to be provided with a Two Year Parts replacement Guarantee from date of commissioning. The plug-in CO & NO2 sensors shall have a 5-7 year life expectancy and include a 3 year part replacement guarantee.

.4 Alternate Equipment:

1. Honeywell
2. Armstrong
3. Vulcain
4. MSA
5. QEL Gas Detection

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**2.10 ELECTRIC DUCT COILS**

- .1 Provide Thermolex Electric Co. Ltd. forced air electric duct coils of size and performances noted in drawings. They are referred to as D.H. on the Drawings. Each coil shall be built to comply with C.S.A and Hydro Standards and rated for operation on voltage shown on drawings volt supply and have balanced three phase circuitry. Wiring shall be in high temperature wire to suit. Coils shall be 3 phase 208 volt. Verify with Electrical Drawings before ordering coils.
- .2 Each coil shall have galvanized steel frame, nickel-chromium resistance elements rated at 46.5 KW per square metre supported on zircon bushings held in aluminum coated steel supporting brackets; have primary overheat protection provided by built-in thermal primary cut-out of fail-safe type automatically reset; built-in secondary cut-out of fail-safe type as before with manual reset feature; integral air motion proving switch to de-energize coil on "No Air Flow" condition.
- .3 Each coil shall be complete with all necessary controls, relays, control transformers and fused power on/off switch, all built into gasketed external terminal box prewired to terminal blocks, suitably identified for easy connection of power and control circuits. Control box shall not exceed coil in height. Supply each coil to suit controls specified.
- .4 Where contactors or relays are required to handle power load or to conform to C.S.A. Code, provide approved contactors or relays on such coils. Contactors or relays shall be "silent" either sealed mercury type (Durakool BF) contactors or Honeywell R8229A relays or equal.
- .5 Alternate Equipment:
  1. Canadian Chromalox
  2. Westcan Electrical Mfg. Inc.

**2.11 TAILPIPE EXHAUST SYSTEM**

- .1 General

The following bid proposal includes all engineering specifications, installation, training, service and warranty for an Emergency Vehicle Exhaust Extraction System. Any deviations from this specification must be noted. Lowest priced equipment may not be approved if not considered to be equal and not in the best interest of the end user.

- .1 The function of the vehicle exhaust removal system will be to source capture 100% of the exhaust emissions directly at the tail pipe of the vehicle and exhaust those emissions to a specified area safely outside the building.

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- .2 The exhaust system must not interfere with access to the vehicle, nor impede doorways/walkways/or exits that would endanger the welfare of fire personnel. Drooping loops of hose or the hose assembly touching the floor will not be permitted.
- .3 As safety to personnel is of the utmost importance, the system shall be so designed as not to whip or fly back into quarters upon disconnection. Vehicles shall be capable of exiting quarters at normal speed without causing damage to the system or taking any portion of the hose or nozzle assembly along with the exiting vehicle.
- .4 The fan shall automatically start prior to vehicle ignition.
- .5 The exhaust system must move with the vehicle in a forward or reverse direction of travel and have an automatic release design without any positive locking device or air bladder that clamps or binds to the tail pipe. No system that uses the vehicles tailpipe, as a pulling disconnection force will be considered.
- .6 The exhaust system shall utilize a minimum of 15 cm (6") diameter hose.
- .7 The tail pipe exhaust system shall be by Nederman.

.2 System Operation

- .1 The auto-disconnect exhaust system shall be a 24-volt electromagnetic release type that captures 100% of the exhaust emissions directly from the tail pipe and discharges those emissions to a specific location by means of an exhaust fan. Upon emergency dispatch of the vehicle, the exhaust fan shall automatically start prior to the engine being energized. The exhaust fan shall remain in the "on" position for as long as any engine is running. Upon vehicle exit, the hose assembly remains connected to the tail pipe and automatically disconnects at a specified distance outside the door by de-energizing the electromagnet. The nozzle and hose assembly shall smoothly separate from the vehicle and safely retract to the stored position ready to connect to the vehicle upon reentry. Upon disconnection, the hose assembly shall not be permitted to swing wide or touch the floor, possibly endangering personnel or apparatus.

The hose shall remain at the door, ready for reconnection. Once the apparatus has left the building, the fan will automatically shut down after a preset time interval. Upon return, the fan is automatically activated prior to vehicle entry and the nozzle is connected to the tail pipe in a standing position.

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Bending over to connect the exhaust system and expose the operator to harmful exhaust fumes is not permitted. No positive locking device or moving parts shall be permitted to be connected to the tail pipe. After the vehicle has been turned off, the fan can continue to operate for a preset time interval, normally two minutes.

### .3 Scope of Work

- .1 A licensed and insured Contractor shall furnish and install a Source Capture Emergency Vehicle Exhaust Extraction System as designed and specified for the station(s).
- .2 The Contractor shall provide and install a centrifugal exhaust fan with capacity for all connected vehicles and sized for expansion if specified.
- .3 The Contractor shall provide and install an automatic fan start control console. The control console and all internal components shall be UL listed and manufactured in accordance with UL standard 508A and bear the UL label.
- .4 The Contractor shall provide and install all ductwork.
- .5 The Contractor shall be responsible for the delivery, safe storage, and handling of the products and protect them from weather elements.

### .4 Submittals and Codes

- .1 The following submittals and code compliance shall be required:
  - .1 Record building dimensions, note vehicle type and prepare shop drawings that include: equipment position, dimensions, sizes, weights, performance data, and also location and size of field connections.
  - .2 Product Data: Provide manufacturer's literature and data sheets indicating rating capacities, dimensions, weights, accessories, and electrical requirements, wiring diagrams, location and size of field connections.
  - .3 Provide fan curves with specified operating point clearly plotted.
  - .4 Submit fan sound level data for fan specified.
  - .5 Manufacturer's Installation, Operation and Maintenance Manual, which outlines the procedures required for system installation, start up, operation and shut down. The instructions shall include the manufacturer's name, telephone number, model number, service manual number, parts list, and brief description of all equipment and the basic operating features. The maintenance instructions shall list routine maintenance procedures, and troubleshooting guide.



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- .6 Certifications: International Quality System Standard ISO 9001 and ISO 14001 Certified. UL Certification: UL listing, 508A Industrial Control Panel bulletin. Compliance with: NFPA 1500, 2003 International Mechanical Code, NIOSH CIB #50, OSHA 2001 American Conference of Governmental Industrial Hygienists (ACGIH) 2002 Proposed Regulations for Benzene and Diesel Exhaust Fumes. Federal Communications Commission approvals.
- .7 Compliance with all State and Local mechanical, electrical and building codes: Uniform Mechanical Code (UMC), American Society of Manufacturing Engineers (ASME), National Electric Code (NEC), Uniform Building Code (UBC), American Institute of Steel Construction (AISC), Sheet Metal and Air Conditioning Contractors National Association (SMACNA), American Society of Testing Materials (ASTM).

.5 Equipment

.1 Suction Rail Assembly

The Suction Rail shall be a polished aluminum extrusion that is formed in a configuration such that the extrusion serves not only as a suction duct, but also as the guide rail that the extraction trolley travels in. The wall thickness of the aluminum extrusion shall be no less than 2.381 mm (0.09375"). The weight of the aluminum extrusion is 6.8 kg/m (4.6 lbs. per lineal foot). The area of the aluminum extrusion, in a cross-sectional view, shall have the minimum equivalent area of 189 cm<sup>2</sup> (0.2035 sq. ft.) with an overall length as specified and indicated on the drawings. Each open end of the suction rail shall be covered with an end cap that can also be used as a round duct outlet for 15 cm (6") diameter exhaust duct. As an alternate outlet, one or more rectangular-to-round transitions can be mounted on the topside of the suction rail after the cutout has been made per the manufacturer's specified size. A pair of EPDM rubber seals is installed at the bottom of the extrusion opening. The rubber seals have a Teflon strip on the inside surface which enables the trolley to travel smoothly and unhindered. The rubber seals close tightly during fan operation for an airtight seal, but open evenly around the trolley during trolley travel. The suction rail shall be supplied with internal rubber bumpers installed at both ends that serve as secondary stops to the trolley. The suction rail shall be supplied with suspension attachments that are specifically designed for fastening to the configuration of the suction rail. Spacing of the suspension attachments shall not exceed 16 feet center-to-center.

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### .2 Extraction Trolley Assembly

The Extraction Trolley Assembly serves as the component in the Rail System that travels in the suction rail, carries and supports the vertical hose assembly, balancer, current collectors, shock absorber and trolley stop mechanism. The Extraction Trolley body shall be made of light weight composite with a low friction surface on each side to enable the trolley to travel smooth through the rubber seal. Also, on a formed bracket mounted to the composite body, shall be a Disconnection box, acting as a circuit breaker for the Electro Magnet. The rail design must be capable of handling up to 4 vehicles parked in tandem.

### .3 Balancer

Integrated to the Extraction Trolley Assembly is a Balancer. The adjustable tension Balancer shall retract the hose and nozzle away from the vehicle as it leaves the building and safely suspend the assembly off the floor in the storage position when not in use. The Balancer shall have a spring characteristics that ensure that the cord is wound onto the drum at a safe and constant speed.

### .4 Vertical Hose

The Upper Vertical Suction Hose shall be 16 cm (6.2") in diameter, and of suitable flexibility to have a compression ratio of minimum 8:1. The hose material shall be Trevira fabric covered with HYPALON (CSM, Chloro-sulfonated polyethylene). The hose shall be fire resistant according to DIN 4102 B1. The lower hose shall be designed to withstand a 260° C (500° F) engine temperature in conjunction with induced ambient air for cooling. The hose shall be capable of withstanding temperatures of 171° C (340° F) continuously, up to 188° C (370° F) on an intermittent usage basis. (NOTE: If a 'closed type sealed system' is being used, the temperature ratings must be 360° C [680° F] and 393° C [740° F] respectively.) The helix shall be external and made of aluminum. The helix shall have high flexibility and the fabric able to withstand oil, chemical, ozone and weather resistance.

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### .5 Nozzle

The Nozzle shall be a minimum of 20cm (8") diameter and designed to capture 100% of the vehicle exhaust fumes generated at the vehicle tail pipe and is held in place by spring tension in conjunction with the electromagnet connection. The nozzle permits an ambient air mix in the air stream to immediately reduce exhaust emission temperatures up to 50% at the point of capture. The reduced air stream temperatures prolong component life by not permitting thermal breakdown of materials.

The Nozzle shall be designed so as not to cause or create back pressure on any vehicle engine, nor draw raw diesel- or gasoline fumes into the exhaust hose while connected to a non-operating vehicle, nor create the possibility of spinning a non-lubricated turbo which could result in bearing failure.

In a 'closed type sealed system', a pressurized container is created presenting an explosive potential when drawing raw fumes from a non-operating vehicle and all system electrical components must be of explosion proof design. No closed system will be considered. These conditions are non-existent with an ambient air mix nozzle design.

The operator never has to touch the Nozzle for connection, but can position the Nozzle over the tail pipe while the operator grips the hose handle and simultaneously connects the electromagnet to the anchor plate. Tension will be automatically applied to the Nozzle created by an internal leaf spring assembly, which holds the Nozzle firmly in place over the tail pipe. The positioning of the electromagnet on the vehicle, combined with the tension created at the Nozzle, shall not allow the Nozzle to come away from the tail pipe until the electromagnet is either automatically or manually de-energized. The Nozzle shall be constructed of both metal and rubber, with no internal movable parts related to the connection of the Nozzle to the tail pipe. The Nozzle Hose shall be a minimum of 16 cm (6.2") in diameter. The hose material shall be lightweight coated fiberglass with a smooth bore. The galvanized steel helix shall be completely rubber covered. The inlet diameter at the Nozzle is oversized to allow maximum airflow capacity for large engines and/or pump tests.

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The inlet boot of the Nozzle is to be made of EPDM rubber, and bonded to a sturdy 24 gauge steel conical reducer. The design of the nozzle shall allow for maximum flexibility to accept a variety of tail pipe configurations, which typically terminate at 90° to the side of the vehicle. Tail pipe adapters are not permitted nor required. No positive locking devices or a concept of a positive locking device, pneumatics, internal or external air hoses, wires, airbags, valves or precautionary devices for pneumatic bursting pressure, magnetic (earth magnet type) shall be permitted or allowed.

### .6 Electromagnetic Assembly

An electromagnet shall be used as the means of keeping the nozzle and hose assembly attached to the vehicle, whether at rest or as it moves to the point of exit. The electromagnet shall be 24 volts, DC with power supplied via an insulated conductor encapsulated within the helix of the upper hose. The electromagnet assembly shall consist of a nitro carburized electromagnet disc, a manual override switch, and an anchor plate.

The electromagnet disc assembly shall be slightly recessed to serve as a guide for ease of connection to the anchor plate mounted on the vehicle and serve as the energized contact point. The formed collar shall be of a smooth and rounded configuration to prevent hooking or catching on external devices of the vehicle.

A manual override switch shall be easily accessible to disconnect the hose assembly while accessing storage compartments or performing vehicle maintenance. The manual override switch shall be conveniently mounted facing the operator. The purpose of the switch shall be to manually de-energize the electromagnet, allowing the hose and nozzle assembly to come away unrestrained from the vehicle when in the parked position within the building.

The 24-volt UL switch shall be surrounded and mounted in a closed cell water resistant neoprene jacket.

The Anchor Plate shall be mounted on the vehicle to allow the operator, in an upright position, to connect the electromagnet. The Anchor Plate shall have an outer circular isolated holder made of hard resilient plastic. Recessed in the center of the holder shall be a finished, Nedox treated steel disc to receive the electromagnet. The Anchor Plate shall be positioned on the vehicle in relation to the vertical and horizontal centerlines of the tail pipe outlet.

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.7 Disconnection Switch

Affixed to the Rail near the exit door, shall be a permanent magnet, which in conjunction with the disconnection box causes a 24-volt electromagnet to disconnect the hose assembly from the vehicle. The separation of the entire hose assembly from the vehicle is a one step process whereby no stress or strain is transferred from the vehicle to the exhaust hose or overhead brackets. Numerous mechanical functions to achieve nozzle separation such as valve activation, pneumatic deflation, and pulling forces to remove the nozzle from the tail pipe are not permitted. The disconnection switch shall be adjustable to create a nozzle release point at a specified distance as the vehicle exits the building. If a proper disconnect does not occur, the electromagnet has a built-in safety disconnection feature, which releases it with a 50-pound shear force. Then the hose and nozzle assembly remains intact. With other systems utilizing a mechanical or pneumatic direct connection to the tail pipe, a breakaway system is required to prevent the entire hose assembly from leaving the building with the vehicle.

.8 End Stop

The Rail shall be equipped with an End Stop, one for each Trolley, which is designed to stop the travel of the entire hose, nozzle, and balancer assembly. The stopping action itself must be spring cushioned to prevent the assembly from coming to an abrupt and immediate halt at an exit speed of up to 24 km/h (15 mph). The End Stop consists of a coiled spring hydraulic oil damper, which is located in the front end of the each Suction unit.

.9 Fan Auto-Start

The Fan Auto-Start serves to act as a remote control for fan start up to ensure the exhaust system is always running whenever an emergency vehicle is in operation. Upon dispatch, the exhaust fan shall automatically start and be running at full rpm prior to engine start up via a radio frequency transmitter mounted within the vehicle. The fan stays on as long as any vehicle is in operation.

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Upon vehicle exit or shut down, a variable timer then activates and the fan automatically turns off after a variable timed cycle. Upon vehicle return, the transmitter shall automatically activate the exhaust fan prior to the vehicle entering the building. The fan remains in operation until all vehicles are turned off and the timer then activates. The Control unit shall be FCC-approved and shall not interfere with radio communications garage doors or on board computers.

### .10 Centrifugal Fans

The fan shall be a direct drive centrifugal type, high pressure, single width, single inlet as required or indicated. Impeller wheels shall be of a modified radial tip design, with top forward curve and airfoil thickness configuration characteristics. Impeller wheels shall be spark resistant and made of aluminum to prevent static electricity build up. The impeller shall be dynamically and static balanced, and of the non-overloading type to provide maximum efficiency while achieving quiet, vibrations free operation. The fan housing shall be manufactured from cast aluminum. The fan and motor assembly shall be mounted on a galvanized steel frame, which shall protect the motor, while also serving as a mounting platform for field installation.

For fans 5 HP and larger, centrifugal fans shall be fully enclosed, single-width, single-inlet steel construction as required or indicated. Impeller wheels shall have backward inclined or backward curved blades of the non-overloading type. The bearings shall be self-aligned ball bearing type permanently sealed and lubricated. Fan shafts shall be steel and rotate in a non-sparking aluminum rubbing ring. Fans shall be accurately finished, and shall be provided with key and key seats for impeller hubs and fan pulleys. The fans shall be furnished with factory finish protective weather coating and a drain kit.

The motor shall be totally enclosed fan cooled (TEFC). Motor starters shall be magnetic with general-purpose enclosures. The fan shall be structurally supported and provided with vibration isolators as specified to ensure quiet and smooth operation. The exhaust discharge outlet shall be in compliance with ACGIH recommendations and EPA requirements. Air intakes, windows, cascade systems, prevailing currents, communications equipment and building aesthetics will be considered in the final location of the fan. Exhaust filtration systems will be provided upon request and silencers will be provided when needed. All fans are tested in accordance with AMCA Standards in an AMCA approved test facility.

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### .11 Air Flow Performance

Fan capacity shall be sized as such as to deliver a 650 cfm (or as otherwise specified) at each hose drop to the vehicle being served. The exhaust system shall pull exhaust into the nozzle also inducing ambient air. The system shall be designed entirely for a negative pressure vacuum method of exhaust extraction. At no point in exhaust system will ducting be under positive pressure. Exhaust system hose drops shall be sized to maintain equal or larger cross sectional diameters than vehicle tailpipe. Exhaust systems, which do not size hose drops in accord with the vehicle engine capacity, as well as vehicle tailpipe diameter, shall not be accepted. The purpose of this portion of the specification is to insure that the exhaust system is designed to cool down exhaust as they are conveyed to the outside of fire station. This type of exhaust extraction keeps exhaust temperatures well below their designed temperature tolerances. This also prevents thermal break down of hose material thus adding years to system life. Exhaust systems that size exhaust drops without dilution ventilation and also down size the exhaust connection hose, unnecessarily put the vehicle engine warranty at risk.

The delivered volume shall take into account all lengths of ductwork, elbows, and branches, shut off, wyes, etc., which accumulate the static pressure at the fan inlet. Manufacturer provided fans shall be performance guaranteed.

### .12 Duct Work

Ducts, unless otherwise specified or approved, shall be round and conform to the dimensions as shown on the drawings. Ducts shall be straight and smooth on the inside with airtight joints. Wherever ducts are used with crimped ends, the joint shall have crimp and bead arrangement. The bead shall provide a rigid stop for the mating open end to seat. Ducts shall be constructed of galvanized steel and sealed in accordance with standard SMACNA methods, for the system designed negative pressure in inches w.g. All duct joints to sealed and air tight.

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.13 Duct Fittings

Reducing fittings shall have a minimum of 2.54 cm (1") graduating increase in diameter per 20 cm (8") in length. Elbows up to 30 cm (12") in diameter shall have a centerline radius of not less than 1.5 times the diameter. Elbows beyond 30 cm (12") in diameter shall have a centerline radius of not less than 2.5 times the diameter. Branches shall enter the mains at a specified angle of not less than 30° with the centerline of the main duct in the direction of airflow, unless otherwise indicated or approved. Flexible connections to the main or branch duct shall be braced with approved metal straps or members.

.14 Connections

Where duct of dissimilar metals are connected, or where sheet metal connections are made to fan inlet and outlet, only an approved fireproof flexible connection shall be used. The connection shall be installed and securely fastened by zinc coated steel clinch type draw bands for round ducts.

.15 Framed Openings and Duct Sleeves

Duct sleeves shall be provided for all round ducts  $\leq 38$  cm (15") diameter that pass through floors, walls, ceilings, or roofs. Sleeves in non-load bearing walls shall be fabricated of 20-gauge steel conforming to ASTM A 525. Sleeves in load bearing walls shall be fabricated of standard weight galvanized steel pipe conforming to ASTM A 53. Collars for round ducts  $\leq 38$  cm (15") shall be fabricated from 20 gauge galvanized steel. Round ducts  $> 15$ " in diameter passing through floors, walls, ceilings, or roofs shall be installed through framed openings. Structural steel members for framed openings shall conform to ASTM A 36. Framed openings shall provide a 2.54 cm (1") clearance between the duct and the opening. A closure collar of galvanized steel  $\geq 10$  cm (4") wide shall be provided on each side of the walls or floors where sleeves or framed openings are provided.

.16 Stack Head

The exhaust discharge stack head will be a no loss type as recommended by ACGIH or as otherwise specified. The stack head design will protect against weather elements or introduction of debris.



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**.17     Duct Test Holes**

Test holes with covers shall be provided where indicated or directed, in the duct and plenum to insert Pitot tubes to take air measurements for balancing the air moving system if required.

**.18     Controls**

The operation of the fan is controlled by a radio transmitter wired to the ignition of the fire truck. As soon the truck is started, the radio transmitter sends a signal to the radio receiver which is wired to the fan starter. The fan starts immediately. A timer in the receiver keeps the fan on for a period of 3 minutes after the transmitter is out of range, ensuring all residual exhaust gasses are captured.

Upon the return from the emergency call, the radio receiver will automatically detect the signal from the radio transmitter from a distance of approximately 30 meter (90 feet) and the controller will start the fan. The fan will stay on for a period of 3 minutes after the truck is turned off, ensuring all residual exhaust gasses are captured.

Sequence of operation:

1.     The operator activates the ignition on the fire truck
2.     Transmitter sends signal to start the fan
3.     Truck returns to fire station and operator turns off the fire truck
4.     Fan stops automatically after 3 minutes

**2.12     DX FAN COIL UNITS**

- .1     Provide Daiken fan-coil units where shown on drawings.
- .2     Unit shall be certified to deliver published heating and cooling capacities when tested in accordance with current ARI Standard 441. Each unit, options and accessories shall be wired and assembled in accordance with NEC. Each unit (without options and accessories) shall be UL listed.
- .3     Fan shall be centrifugal, forward-curved, double width type and shall be both statically and dynamically balanced. Fan wheels and housing shall be of galvanized steel.
- .4     Unit shall be complete with H.W. coil, centrifugal fan and motor, insulated condensate pan, electric coil 3-speed fan switch and 18 gauge galvanized steel casing panels. Each unit shall have factory installed internally lined plenum.

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- .5 Cabinet shall be constructed of cold-rolled steel, bonderized and coated with baked enamel finish. Access panels shall have positive locking quarter turn fasteners for easy removal. Fasteners shall be slotted head type. Each unit shall be complete with sound-lined return air plenum.
- .6 Interior surfaces of casing panels shall be insulated with 13 mm thick glass fiber meeting NFPA-90A requirements. Condensate pan shall be lined with 13 mm thick fire retardant closed cell foam insulation.
- .7 Fan motors shall be 3-speed, tap-wound type with integral motor protection. Motors shall be shaded-pole type.
- .8 Motor bearings shall be of sleeve type with oil tubes and oversized oil reservoir to ensure positive lubrication.
- .9 Coil shall give capacity shown with staggered 13 mm OF copper tubes and mechanically bonded aluminum fins. Coils shall be leak tested at 2413 kPa minimum air pressure, and shall be suitable for up to 1724 kPa working pressure. Each coil shall have a manual air vent. Coil sweat connections shall be 16 mm OD copper.
- .10 Filter shall be 25 mm thick throwaway type. Provide one set of spare filters for all units. Filters must be easily accessible after installation of unit and shall be removable from below. Filters with fiberglass material are not allowed.
- .11 Primary drain pans shall be of 18 gauge galvanized steel. Pans shall be pitched for positive drainage and shall project under full length of coil, including return bends and headers.
- .12 Alternate Equipment:
  - 1. Trane
  - 2. Carrier
  - 3. Mitsubishi

#### 2.13 DX AIR COOLED CONDENSING UNIT

- .1 Unit shall be Daiken Model packaged condensing unit for outdoor mounting. Unit shall be C.S.A. and A.R.I. approved for service and have a 5 year re-supply warranty on each compressor section. Unit shall meet ASHRAE 15 and ASHRAE 90.1.
- .2 Unit shall have ton capacity. Unit shall have low ambient kit for -8oC operation. Unit heat rejection shall be an outdoor temperature of 35°C.

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- .3 Unit shall be fully weatherproofed for outdoor installation. Casing shall be of galvanized steel, bonderized and finished with baked enamel or equivalent corrosion resistant surface of paint type. Openings shall be provided for power and refrigerant connections. Panels shall be removable to provide access for servicing. Compressor and control box shall be located in compartment other than that which contains condenser coils.
- .4 Unit shall operate in conjunction with furnace. Provide necessary controls, terminals, relays, etc., to complete system. See Temperature Controls.
- .5 Units shall be built for operation on voltage noted on drawings. Supply all wiring diagrams necessary to complete system. Diagrams shall be for specified system including controls, interlocks, safety devices, etc. Verify in field that installation conforms to wiring diagrams and system operates correctly.
- .6 Compressor and condenser fans shall be internally vibration isolated.
- .7 Compressors shall be industrial grade energy efficient direct drive 3600 RPM maximum speed, scroll type.
- .8 The condenser coil shall be of aluminum fins mechanically bonded to copper tubing.
- .9 Set units on vibration isolators on roof sleepers.
- .10 Electrical Division will provide weatherproof disconnect switch at units and terminate at line side of units control panel. Provide all wiring necessary to complete system.
- .11 Startup units to operate in conjunction with correspondent air handling units. Set up and adjustment controls and operating devices to put units in safe, efficient operation condition to approval of Unit Manufacture.
- .12 Provide five (5) minute anti-cycle and interstage time delay timers. Provide hot gas bypass connection on the lead compressor. Provide 115 volt control circuit with fusing and control power transformer. Unit shall be wired with contactors for compressor and condenser motors. Compressor overload protection, high/low cutouts and differential oil pressure control.
- .13 Unit shall use R410A or R407C refrigerants.
- .14 Unit total refrigerant charge shall not exceed 4.4lbs.

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.15 Alternate Equipment

1. Carrier
2. Trane
3. Mitsubishi

**2.14 STEAM HUMIDIFIER**

.1 Work Included:

- .1 Condair EL Series electrode steam humidifier[s] as indicated on drawing[s] and as indicated on schedule[s].
- .2 Complete and operable humidification system [which meets applicable building codes]
- .3 Equipment start-up and project inspection by qualified factory trained representative.

.2 Quality Assurance:

- .1 Certifications, C-UL US Listed.
- .2 ISO 9001.
- .3 ANSI/NFPA 70 - National Electrical Code.
- .4 AHRI 640, Standard for Commercial and Industrial Humidifiers.
- .5 ASHRAE Standard 135 BACnet

.3 Related Sections:

- .1 23 Mechanical General
- .2 23[ ] Piping Installation
- .3 23[ ] Control System

.4 Submittals:

- .1 Submit product data under provisions of Section 23. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes. Include rated capacities, operating weights, furnished specialties, and accessories.
- .2 Submit manufacturer's installation instructions.
- .3 Submit operation and maintenance data.
- .4 Submit coordination drawings. Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, and dispersion tubes. Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, and required clearances.
- .5 Submit wiring diagrams including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- .6 Submit water pressure requirements.

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- .5 Schedules:
  - .1 Refer to information contained in schedule[s] attached to this specification.
  - .2 Humidifiers to be of type, capacity, and arrangement as listed in schedule[s].
  - .3 Include accessories listed in schedule[s] and those accessories required for type of unit.
  
- .6 Electrode Steam Humidification System - Model Nortec EL
  - .1 Unit[s] to be complete with:
    - .1 Provide Condair EL electrode humidifier generating mineral-free, sterile steam from a potable water supply Packaged unit, wall mounted, atmospheric steam generation using an electrode steam cylinder[s]. Resistive element technology and boiler steam (pressure steam) technology not acceptable.
  - .2 Unit[s] to be complete with:
    - .1 Touchscreen controller with standard building automation:
      - .1 Intuitive touchscreen control with color graphic user interface.
      - .2 Standard building automation communication protocols BACnet IP, BACnet MSTP (Slave only) and Modbus. Additional hardware required for building automation communication not acceptable.
      - .3 Embedded web interface for easy configuration and remote monitoring from any computer with a web browser over a local area network (LAN) connection.
      - .4 USB interface for new software/feature upload and download of operational information.
      - .5 Single or dual channel analog signal acceptance, supporting both demand and transducer control. Ability to control setpoint from humidifier control when using transducer controls.
    - .2 Packaged system with Condair electrode cylinder technology:
      - .1 Condair cylinder optimized for humidifier capacity and supply voltage. Cylinder must have welded seam to ensure watertight and have high water sensor to prevent overfilling.
      - .2 Durable powder coated steel cabinet with zero side clearance requirement for minimal footprint.
      - .3 Insulating air gap between plumbing and electrical compartment for increased electronic reliability.
      - .4 Standard internal drain water tempering to ensure maximum 140° F [60° C] drain water. External drain water cooler not acceptable.

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- .5 Integral fill cup with minimum 1-inch [25 mm] air gap to prevent back siphoning.
- .6 Full cylinder indication and pre-notification of automatic shutdown at end of cylinder life.
- .7 Automatic pulse feature to clean any obstruction from the drain solenoid valve if required.
- .8 Automatic off-season shut-down [after 3 days of "no call"] will completely drain the cylinder[s] and automatically restart on call for humidity. Adjustable on/off and time sequence. Provides extended cylinder life, while ensuring stagnant water does not remain in the system.
- .3 Condair Auto-Adaptive Control water management:
  - .1 Advanced water management utilizing the patented Proportional plus Integral Auto-Adaptive Control system for optimal energy efficiency, water usage and cylinder life.
  - .2 98% thermal efficiency from startup until end of cylinder life.
  - .3 Drains automatically optimized to water conditions to maximize cylinder and reduce water usage.
  - .4 Modulating output between 20% and 100% of rated capacity.
- .3 Optional Accessories
  - .1 Refer to 'Option schedule'
- .4 Acceptable Alternates
  - .1 Dristeam

### **PART 3 - EXECUTION**

#### **3.1 STANDARD DUCTWORK**

- .1 Provide ducts and sheet metal shown and required to complete duct systems and put each in operating condition. Sheet Metal Trade is responsible for laying out this work. Drawings showing ducts must not be used for obtaining dimensions for layout except where dimensioned. Mechanical Drawings indicate general location and route of ductwork to be installed. General layout of ducts may be taken from Drawings but this Section is responsible for avoiding interferences with other Sections not specifically shown on Mechanical Drawings. Actual measurements shall be taken at building before ductwork is fabricated.

#### AIR DISTRIBUTION

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- .2 Make without additional charge, any necessary changes or additions to layout of ductwork to accommodate structural, duct, piping, ceilings, electrical or equipment conditions, etc. Where openings in walls for ductwork have been provided by others, make full use of such openings by fabricating ductwork to fit them or if necessary, provide offsets and transitions to suit. Location of ducts may be altered if change is made before installation, is submitted in writing, is approved by Architect and does not cause Owner or other Sections any extra expense.
- .3 Construct ductwork (unless otherwise noted) of galvanized or first quality smooth finished, cold rolled galvanized steel guaranteed to double seam without fracturing of following thickness:

<u>Longest Side</u>	<u>Steel</u> mm-USG	<u>Colour</u> <u>Code</u>
Up to 300 mm	0.5-26	Blue
301 to 750	0.6-24	Orange
751 to 1375	0.8-22	Green
1376 to 2150	1.0-20	Yellow
2151 & Over	1.3-18	White

- .4 Make duct work exposed to weather of soldered construction, prime painted and finished in two coats of alkyd paint in approved colour unless protected or noted.
- .5 Form ducts with thickness (gauge) markings or colour coding on exterior of ductwork visible from floor.
- .6 Make joints suitably air tight with laps in direction of air flow. Wherever possible, sizes of ducts shall conform to those indicated. Where building conditions require shape be modified, ducts must have same cross-sectional area indicated and width of duct shall not exceed six times depth except with special approval. Ductwork shall be in accordance with ASHRAE Guide of latest publication. Duct leakage shall not exceed 3% of air volume at 500 Pa S.P.
- .7 Construct ducts up to 600 mm with reinforced ribs formed by pocket slip spaced not more than 2400 mm apart. Make ducts 600 mm and over in either dimension with reinforcing rib formed by pocket slip spaced not more than 1200 mm apart. Provide supplemental stiffening, etc. to prevent drumming and make a structurally sound assembly. Cross-break all duct faces except those to which rigid board type insulation is to be applied.
- .8 Install in ductwork where shown or required, controls, thermometers, motorized dampers, coils, filters, smoke, fire and freeze detectors, etc., in accordance with setting instructions supplied by equipment supplier.

### AIR DISTRIBUTION

- .9 Hang round ducts exposed to view with 25 x 3.2 mm single strap and all round duct band. Obtain approval of method and material before commencing work. Where fittings are not available factory made, they shall be five piece formed fittings to give equivalent air flow performance to approval.
- .10 Make downstream end of each section of concealed round ducts small and beaded. Assembly by inserting small end into upstream end of adjoining section. Fasten joints in place by sheet metal screws spaced not over 75 mm apart and joint tape seal to approval with Arno #C-520 or Duro Dyno G.S. duct tape.
- .11 Assemble various duct sections with Snap-Lock or Pittsburgh lock and grooved longitudinal seams carefully closed for tightness and appearance. Join duct sections with pocket slip sized to conform to following requirements:

<u>Maximum Side Duct</u>	<u>Duct mm-USG</u>	<u>Slip mm-USG</u>	<u>Slip Size</u>	<u>Slip Reinforced</u>
Up to 300 mm	0.5-26	0.5-26	25 mm	No
301 to 750	0.6-24	0.6-24	25	No
751 to 1375	0.8-22	0.8-22	25	4 x 35 mm
1376 to 2150	1.0-20	1.0-20	38	4 x 35 mm
2151 & Over	1.2-18	1.2-18	38	4 x 35 mm

- .12 Support duct assemblies and components from building structure with 25 x 1.3 mm thick galvanized steel 'Z' band hanger secured under ducts. Support ducts over 900 mm size with 6.4 mm steel rods and 32 x 32 x 6.4 mm angle iron up to 1800 mm and 50 x 38 x 9.5 mm angles and 9.5 mm rods for larger sizes. Space hangers at not over 1800 mm centres. See 21 05 01-20 and 21. Use aluminum hangers for aluminum ducts.
- .13 Make radius of turns at least one duct width. Where space prevents such radius, make turns square and fit with turning vanes of double faced hollow type with Duro Dyne vane-rails secured with sheet metal screws.
- .14 Provide splitter damper in each supply take-off whether shown on drawings or not. Provide manual balancing damper in each return or exhaust takeoff set as close as possible to trunk duct. Make turning vanes, dampers, deflectors, splitters of same material and thickness as for equal size ductwork with formed edges, cross-broken and stiffened. Fit balancing dampers with lockable quadrant operator. Fit splitter dampers with rod-operators spaced at maximum 600 mm centres. Splitters shall be full depth of branch duct and 1-1/2 times branch width. Dampers in ducts having one side larger than 300 mm shall be multiblade.



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AIR DISTRIBUTION

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- .15 Seal all duct joints during construction with Air Duct sealant. Apply to faces of joints before cleats are installed where space is restricted and after cleats are installed where access is available.
- .16 Install grilles, registers and diffusers to manufacturer's direction. Supply and install baffles in diffusers to suit air pattern. Adjust grilles and registers to give required air throw and pattern.
- .17 Provide access doors of suitable size (min. 300 x 400 mm) for access to installed equipment in ducts and where necessary for access to motorized, balancing and Fire Dampers. Make doors of 0.8 mm galvanized steel hinged to 0.8 mm galvanized mounting frame with approved quick opening fastening devices to give tight closure on fire resistant gasket. Provide access in ceilings where necessary for splitter and balancing dampers. Provide concealed operators for each splitter or balancing damper above fixed ceiling.
- .18 Provide extension collars for outlets, sound absorbers, air guide vanes and other special features as indicated or required including connections to equipment provided by Owner or other Sections. Transition ducts at not more than 30 degree slope to full size of each grille, register, louvre, coil or equipment.
- .19 Paint inside of duct connections behind each grille and register with two coats of black non-reflective paint to visually conceal duct interior to approval.
- .20 At floor line and at other points where ducts join louvres, concrete or masonry construction or where ducts pass through floors, rivet ducts on approximately 150 mm centres to 38 x 38 x 3 mm galvanized steel angles secured with expansion shields and bolts on approximately 300 mm centres and caulk air and water tight. At louvres, drill blades for drainage.
- .21 Install ductwork to clear structural members and any fire-proofing. Locate ducts to permit their proper insulation where required. Do not remove or damage structural fireproofing. Leave space to permit insulation and fireproofing to be inspected and repaired.
- .22 Seal all ducts entering ceiling plenums air and noise tight with fibreglass packed snug around all four sides and sealed with approved incombustible caulking/sealing compound to approval. If openings are larger than 25 mm, cement grout opening and then seal to approval. Report all other openings left unsealed in writing.
- .23 Provide 12 x 12 mm mesh galvanized steel birdscreen over intake of each fresh and open air duct. Hinge birdscreen on upstream end of ducts for easy opening and secure with catches at not more than 600 mm centres.

#### AIR DISTRIBUTION

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- .24 Ducts passing through roof shall have suitable approved minimum 300 mm high curb built and flashed over by another Section. Counter flashing of ducts by this Section, of same material and finish as flashing. See 21 05 01, Flashings.
- .25 Inside paint and seal all fresh air intakes, all fresh and mixed air ducts to Heat Reclaim Unit, supply fan; and relief or exhaust ducts from motorized or gravity backdraft dampers to exterior outlets with two coats of C.I.L. #979 Houseguard or other approved anti-corrosion paint.
- .26 Arrange ducts to drain to exterior at louvres. Pipe low points of fresh air and exhaust ducts at fixed louvres and roof outlets to Hub Drain in 32 mm DWV copper pipe. Provide 6 x 6 mm mesh heavy copper screen over each inlet with trap on run. Provide access door to each drain screen.
- .27 Provide flexible connections between equipment and duct work and where shown. Provide suitable sheet metal rain guard for exterior fabric connections secured to fan only.
- .28 Provide acoustic liner in all fan coil units supply and return ductwork as outlined below. Where ducts are acoustic lined, sizes shown shall be inside liner.
- .29 Provide Duct Liner acoustic liner in duct work at each exhaust fan inlet connection for not less than 3 m back from inlet including branches. Acoustic line all supply and return ducts for heat pumps and 6m of heat recovery unit supply and exhaust ducts from unit.
- .30 Acoustic Treatment Installation:
  - 1. Adhere the liner to the interior sides of ductwork with a minimum of 75% coverage of an approved cold waterproof adhesive, Bakor #230-38.
  - 2. In addition, use mechanical fasteners, mechanical pins, adhered clips or adhered nylon pins. Do not drill or punch holes through the ductwork.
  - 3. Insulation shall be applied with all joints in close mechanical contact and all joints and voids shall be filled with an approved waterproof fire retardant mastic. Waterproof mastic shall be applied over all anchors where they pierce the covering.
  - 4. The ductwork must be enlarged in these areas to maintain the same cross-sectional area shown on the plans.
  - 5. Protect leading edge of liner with a 1" (25 mm) metal strip.
- .31 Blank off unused portions of exterior louvres with 50 mm thick 72 g/m<sup>3</sup> density rigid fibreglass board sandwiched between two 1 mm aluminum sheets secured in place to approval. Paint surface next to louvre two coats of matte black over suitable primer.

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AIR DISTRIBUTION

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- .32 At floor line, and at other points where sound attenuators join concrete or masonry construction, rivet attenuators on approximately 150 mm centres to 38 x 38 x 6.4 mm galvanized steel angles secured to masonry with expansion shields and bolts on approximately 600 mm centres and caulk air tight. Make joints with gaskets and sealing compound between angles and surfaces. See Carrier Design Manual, Part 2, Page 15, Fig. 15. Balance of openings shall be concrete grouted.
- .33 Provide where shown, flexible air duct hoses. Secure hose to metal ducts with attachment screws and band clamps and tape seal with Permascreen fiberglass duct tape. Minimum length 25% longer than measured distance. Maximum length 50% more than measured length (max. 2 m). Provide manual balancing damper in trunk duct at connection to each flexible duct.
- .34 Provide pitot tube opening enclosures with cap and chain in ductwork for each supply, return and exhaust system. Provide openings at all supply fan discharges, at return fan inlets and exhaust fan inlets, before and after silencers and heating coils in ductwork, and at main branch duct take-offs. Locate openings in straight duct runs. Provide a minimum of three holes per duct at each of above locations, and at not more than 450 mm centres.
- .35 Round ducts exposed to view shall be Alpha Industries Limited (Mississauga) "Multi-Rib" 26 gauge satin coat galvanized steel spiral lock seam duct with "ASM" preformed fittings. Hang ducts with 25 x 3.2 mm single strap and all round duct band. Obtain approval of method and material before commencing work. Where fittings are not available factory made, they shall be five piece formed fittings to give equivalent air flow performance to approval.
- .36 Exposed round ducts shown acoustically lined shall be acoustic lined with 22 gauge perforated metal liner. Fittings shall match ductwork construction, acoustic lined.
- .37 Make downstream end of each section of concealed round ducts small and beaded. Assembly by inserting small end into upstream end of adjoining section. Fasten joints in place by sheet metal screws spaced not over 75 mm apart and joint tape seal to approval with Arno #C-520 or Duro Dyno G.S. duct tape.
- .38 Provide at least three 1.2 mm thick galvanized steel adjustable baffles with SRP24/SRP40 rod operators in mixed air duct to each Supply Air Unit. Baffles shall be full depth of duct approximately 1/3 width. See Sections on Drawings and locate to approval. Adjust dampers to give proper mixing into each Unit.

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#### AIR DISTRIBUTION

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- .39 Provide 100 mm diameter aluminum vent from each clothes dryer ending in roof cap with automatic damper unless otherwise noted. Provide 300 mm long plasticized wire molded flexible connector at each dryer connection. Provide cleanouts on ducts at 2 m centres to approval.
- .40 Provide sound jacketing on ducts and silencers where shown. Externally acoustically encase ducts and silencers with 25 mm thick 72 kg/m<sup>3</sup> density rigid acoustic glass fiber board mechanically fastened. Overlap jacketing at least 300 mm onto silencers except where shown fully jacketed. Extend jacketing between silencers and Mechanical Room wall.
- .41 Provide splitter damper in each supply take-off. Provide manual balancing damper in each return or exhaust takeoff set as close as possible to trunk duct. Make turning vanes, dampers, deflectors, splitters of same material and thickness as for equal size ductwork with formed edges, cross-broken and stiffened. Fit balancing dampers with lockable quadrant operator Duro Dyne #KS-195L. Fit splitter dampers with Duro Dyne #SRP24/SRP40 rod-operators spaced at maximum 600 mm centers. Splitters shall be full depth of branch duct and 1-1/2 times branch width. Extend jacketing between silencers and mech. room wall.
- .42 After final adjustments are made for air handling systems, lock each control device in position and visually indicate required setting. For splitter and balancing dampers, provide additional locking screw or bolt to approval.

### 3.2 FIRE DAMPERS

- .1 Provide Fire Dampers and Fire Stop Flaps where shown or required by Ontario Building Code, local Fire Ordinances and Provincial Fire Marshal.
- .2 Secure each Fire Damper in place in steel sleeve conforming to ULC #S-112 fitted with steel angle frame secured to sleeve to approval. Clean and prime paint all metal parts.
- .3 Fire Stop Flaps shall be installed to manufacturer's printed instructions including ceramic fabric over diffuser or register to complete fire rating to ULC approval.
- .4 Fire Dampers in drywall or at ceilings (not F.S.F.) shall be secured in place independent of ductwork complete with steel channels and wire to manufacturers printed directions.

### 3.3 FIXED LOUVRES

- .1 Connect ducts to louvres so that maximum free area of louver is used and any moisture in ducts will drain out through louver.

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AIR DISTRIBUTION

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- .2 Provide all miscellaneous steel required for the installation.

**3.4 FAN EQUIPMENT**

- .1 Provide Penn fans of sizes, types and characteristics shown in Fan Schedule.
- .2 Supply for each fan noted in Fan Schedule, a Honeywell T4051B Celsius scale 120 volt reverse acting room thermostat to start fan when space temperature exceeds 27°C.
- .3 Supply for each fan noted in Fan Schedule, a Tork #D-100 solid state time switch with battery backup. Timer schedules shall be set as later directed on site.
- .4 Support each cabinet and utility fan on open spring antivibration isolators rated at not less than 95% efficiency so that noise and vibration will not be transmitted to building.
- .5 Set and secure roof exhausters on roof curbs and seal to weatherproof.
- .6 Wire fans to controls as shown in Starter Schedule.
- .7 Wire ceiling circulating fans to start from speed controllers.

**3.5 HEAT RECOVERY UNIT**

- .1 Install units in accordance with Manufacturer's instructions and as indicated.
- .2 Install fan sheaves required for final air balance.
- .3 Install flexible connections at fan inlet and fan outlets.
- .4 Install unit on vibration isolators after securing isolators to curbs.
- .5 Mount thermostats on walls and wire to units.
- .6 Mount unit control panel in warehouse.
- .7 Wire between unit and remote control panel.

**3.6 ELECTRIC DUCT COIL**

- .1 Build each coil in steps noted (System TRT). Provide contactors, transformers, controls, etc. to complete system controls. Each coil will be controlled by 24 volt room sensor in steps to suit coil.

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AIR DISTRIBUTION

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- .2 Each coil shall have air pressure drop 0.1" maximum and be suitable for duct mounting with bolted flanges for easy removal. Coil internal height shall match connecting duct & shall fit space allotted. Each coil shall have inlet protection screen.
- .3 Electrical Division will provide power wiring to line side of each coil terminal only.

### 3.7 TAILPIPE EXHAUST SYSTEM

#### .1 Exhaust System

- .1 The exhaust removal system shall be installed as indicated and recommended by the manufacturer. Welding and brazing shall conform to ASME-17. Slip joints shall be sealed. Riser duct shall be supported to the structure as indicated on the drawings. Main duct shall be attached to building structural members.

#### .2 Building Surface Penetrations

- .1 All penetrations shall be sealed. Sleeves or framed openings shall be utilized where duct penetrates building surfaces. The space between the sleeve or framed opening and the duct shall be packed with mineral wool or approved material. Closure collars shall be installed around the duct on both sides of the penetrated surface. Collars shall fit tight against the building surfaces and snug around the duct.

#### .3 Guide Track

- .1 Installation height of Guide Track shall be between 3 m (10 ft.) to 4.6 m (16 ft.) range or as otherwise indicated on the drawings. The Guide Track shall be installed approximately 36 cm (14") from the side of the vehicle and  $\geq 30$  cm (12") away from the side edge of the exit door. The Guide Track for the exhaust system shall include corrosion resistant brackets for ease of mounting to structural channel, trusses, or angle iron. Brackets shall be a minimum of 0.318 cm (0.125") thickness. Mounting bolts to be no less than 0.953 cm (0.375") diameter (structural grade 8) for connection to steel frame. Bolts required for masonry installation shall be 0.5" x 3.5" expansion bolts, or 0.375" x 4" sleeve anchors for wall mount masonry connection.

Recommendation: Unistrut 1 5/8" or Angle Iron 2"x 2"x 3/16".

## AIR DISTRIBUTION

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.4 Tests

- .1 Each exhaust system and inlet shall be balanced to produce the indicated air quantities within 10 percent at the conditions shown. Any fans with bearings shall be lubricated, and the speed, direction and rotation of each fan shall be checked and verified as running correctly. The running current of each motor shall be checked and verified as correct. Upon completion and prior acceptance of the installation, the exhaust system shall be tested at the operating conditions to demonstrate satisfactory functional and operating efficiency. The Contractor shall provide all instruments, facilities, and labor required to properly conduct the tests.

.5 Training

- .1 The Contractor, or authorized approved personnel, shall provide training to the Owner (or appointed representative) in the daily use of and maintenance of the vehicle exhaust removal system installed and specified herein.

.6 Quality Assurance

- .1 All workmanship, manufacturing procedures, airflow design, and materials shall be tested and performance guaranteed.

.7 Equipment Warranty

- .1 The Contractor shall guarantee all materials, equipment and workmanship for a period of three (3) year from date of final acceptance of the complete job, against original defects of material and workmanship, or excessive wear or deterioration.

### 3.8 CARBON MONOXIDE & NOX MONITORING SYSTEM

- .1 The Installing contractor shall meet all requirements as per the drawings and specifications and as per the manufacturer's installation guidelines.
- .2 The installing contractor shall review with supplier the required number of control relay contacts to effectively interface the gas monitoring panel with fans, Fire Alarm Panels, HOAs and/or remote devices that may not be indicated within this scope.
- .3 Provide complete start up and commissioning service by the manufacturers authorized representative.
- .4 Provide a certificate of calibration from the manufacturer indicating sensors are

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**AIR DISTRIBUTION**

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**3.9 STEAM HUMIDIFIER**

- .1 Installation:
  - .1 Install humidifiers per manufacturers' instructions.
  - .2 Install with required clearance for service and maintenance.
- .2 Accessories:
  - .1 Install accessories in accordance with manufacturer's recommendations.
- .3 Commissioning:
  - .1 Start-up of humidifier to be by factory trained technician.

**3.10 OPERATE AND ADJUST SYSTEMS**

- .1 Operate all systems to full capacity and verify proper, safe efficient operation of all parts and each complete system. Oil motors and grease bearings before operating equipment.
- .2 When work is complete and systems are in operation, adjust valves, belt drives, controls, dampers and thermostats so that there is even distribution of cooling, heating and ventilation air throughout. Turn over to Owner, necessary keys, handles and operating devices for each system.
- .3 It is responsibility of each trade to adjust equipment, dampers, controls, drives and speeds necessary to put each system into its proper design operating condition to direction of Balance/Test Company. Each system shall be within 5% of design figures.
- .4 Arrange within and pay Testing & Balancing Company to perform air balancing for the air distribution systems as directed under Section 23 09 93.

**3.11 QUIET OPERATION**

- .1 Each air handling system has been designed to be quiet in operation, N.C. 35 maximum. It is responsibility of this Section to supply equipment and install systems to ensure noise levels will be maintained satisfactory to Consultant.

END OF SECTION



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BUILDING AUTOMATION SYSTEM

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CONTENTS

SUBSECTION      TITLE

PART 1 - GENERAL

1.1	Related Documents
1.2	Definitions
1.3	General Conditions and Related Documents
1.4	Control System Description
1.5	Quality Assurance
1.6	References
1.7	Submittals
1.8	Record Documentation
1.9	Warranty
1.10	Acceptable Alternates

PART 2 - PRODUCTS

2.1	General Description
2.2	Building Management System Architecture
2.3	User Interface
2.4	DDC System Controllers
2.5	Network Router Controllers
2.6	Input Devices
2.7	Output Devices
2.8	Miscellaneous Devices
2.9	Web-Based Operator Interface
2.10	Application Specific Controllers

PART 3 – EXECUTION

3.1	Building Management System
3.2	Installation Practices
3.3	Training
3.4	Commissioning
3.5	Control Sequence
3.6	Sequence of Operation
3.7	Point Lists

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**BUILDING AUTOMATION SYSTEM**

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**PART 1 – GENERAL**

**1.1 RELATED DOCUMENTS**

- .1 All work of this Division shall be coordinated and provided by the single Control System Manufacturing and installation Contractor.
- .2 The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Mechanical Division Sections for details.
- .3 The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
- .4 If this Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

**1.2 DEFINITIONS**

- .1 Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- .2 Binary: A two-state system where an “ON” condition is represented by one discrete signal level and an “OFF” condition is represented by a second discrete signal level.
- .3 Control and Management System: The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this section Contractor and to be interfaced to the associated work of other related trades.
- .4 This Contractor: The single Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the Integrated controls work.
- .5 Control Sequence: Pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.

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BUILDING AUTOMATION SYSTEM

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- .6 Direct Digital Control: The digital algorithms and pre-defined arrangements included in the software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
- .7 Controls Network: The total digital on-line real-time interconnected configuration of digital processing units, internet/web interface, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.
- .8 Node: A digitally programmable entity existing on the controls network.
- .9 Integration: The complete functional and operational interconnection and interfacing of all controls elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent control system as required by this Division/section.
- .10 Provide: The term "Provide" and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- .11 Provide a web browser-based interface for connection via the internet to the owner's remote workstation.
- .12 Furnish: The term "Furnish" and its derivatives when used in this Division shall mean supply at the Building Management System Contractor's cost to the designated third party trade contractor for installation. Building Management System Contractor shall connect furnished items to the Building Management System, calibrate, test, commission, warrant and document.
- .13 Wiring: The term "Wiring" and its derivatives when used in this Division shall mean provide the wiring and terminations for this section
- .14 Install: The term "Install" and its derivatives when used in this Division shall mean receive at the jobsite and mount.
- .15 Protocol: The term "protocol" and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between Control network nodes. The protocol shall meet ANSI/ASHRAE BACnet Standard 135-2001 and ANSI/ASHRAE BACnet IP Standard 135-2001 – IP Addendum 135b.

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BUILDING AUTOMATION SYSTEM

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- .16 Software: The term “software” and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in DDC/BAS industry for real-time, on-line, integrated controls configurations.
- .17 The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.
- .18 Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.
- .19 The following abbreviations and acronyms may be used in describing the work of this Division:

ADC	- Analog to Digital Converter
AI	- Analog Input
AN	- Application Node
ANSI	- American National Standards Institute
AO	- Analog Output
ASCII	- American Standard Code for Information Interchange
ASHRAE	- American Society of Heating, Refrigeration and Air Conditioning Engineers
AWG	- American Wire Gauge
CPU	- Central Processing Unit
CRT	- Cathode Ray Tube
DAC	- Digital to Analog Converter
DDC	- Direct Digital Control
DI	- Digital Input
DO	- Digital Output
EEPROM	- Electronically Erasable Programmable Read Only Memory
EMI	- Electromagnetic Interference
FAS	- Fire Alarm Detection and Annunciation System
GUI	- Graphical User Interface
HOA	- Hand-Off-Auto
ID	- Identification
IEEE	- Institute of Electrical and Electronics Engineers
I/O	- Input/Output
LAN	- Local Area Network
LCD	- Liquid Crystal Display
LED	- Light Emitting Diode

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**BUILDING AUTOMATION SYSTEM**

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MCC	- Motor Control Center
NC	- Normally Closed
NIC	- Not In Contract
NO	- Normally Open
OWS	- Operator Workstation
OAT	- Outdoor Air Temperature
PC	- Personal Computer
RAM	- Random Access Memory
RF	- Radio Frequency
RFI	- Radio Frequency Interference
RH	- Relative Humidity
ROM	- Read Only Memory
RTD	- Resistance Temperature Device
SPDT	- Single Pole Double Throw
SPST	- Single Pole Single Throw
XVGA	- Extended Video Graphics Adapter
TBA	- To Be Advised
TCP/IP	- Transmission Control Protocol/Internet Protocol
TTD	- Thermistor Temperature Device
UPS	- Uninterruptible Power Supply
VAC	- Volts, Alternating Current
VAV	- Variable Air Volume
VDC	- Volts, Direct Current
WAN	- Wide Area Network

**1.3 GENERAL CONDITIONS AND RELATED DOCUMENTS**

- .1 All work of this Division shall be coordinated and provided by the single Controls Contractor and manufacturer with ability to customize controls.
- .2 The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Mechanical Division Sections for details.
- .3 The work of this Division shall be as required by the Specifications, Schedules and Drawings.
- .4 If the Building Management System Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.
- .5 The single Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the Building Management System work.

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**BUILDING AUTOMATION SYSTEM**

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- .6 The Control System shall be total integrated system of fully operational and functional elements, including equipment, software, programming, network and associated materials, to be provided by this Contractor and to be interfaced to the associated work of other related trades.

**1.4 CONTROL SYSTEM DESCRIPTION**

- .1 The systems should be capable of totally integrated BAS and standalone DDC function. Please refer to drawings to relate the extent of work under current scope. The systems should be fully BACnet listed at each level i.e. room, equipment, and building.
- .2 The Control System shall be capable for use with the LAN/WAN/IT/wireless systems. All points of user interface shall be on Local workstation or standard PC browser. The primary point of interface on these PCs will be a standard Web Browser.
- .3 Keep 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, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned Building Management System.
- .4 Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- .5 Manage and coordinate the Building Management System work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- .6 The Building Management System as provided shall incorporate, at minimum, the following integrated features, functions and services:
1. Operator information, alarm management and control functions.
  2. Network level information and control access.
  3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
  4. Diagnostic monitoring and reporting of functions.

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**BUILDING AUTOMATION SYSTEM**

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5. Offsite monitoring and management access.

**1.5 QUALITY ASSURANCE**

**.1 General**

1. Building Management System Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management System.

- .2 The following abbreviations and acronyms may be used in describing the work of this Division:

ADC	-	Analog to Digital Converter
AI	-	Analog Input
AN	-	Application Node
ANSI	-	American National Standards Institute
AO	-	Analog Output
ASCII	-	American Standard Code for Information Interchange
ASHRAE	-	American Society of Heating, Refrigeration and Air Conditioning Engineers
AWG	-	American Wire Gauge
CPU	-	Central Processing Unit
CRT	-	Cathode Ray Tube
DAC	-	Digital to Analog Converter
DDC	-	Direct Digital Control
DI	-	Digital Input
DO	-	Digital Output
EEPROM	-	Electrically Erasable Programmable Read Only Memory
EMI	-	Electromagnetic Interference
FAS	-	Fire Alarm Detection and Annunciation System
GUI	-	Graphical User Interface
HOA	-	Hand-Off-Auto
ID	-	Identification
IEEE	-	Institute of Electrical and Electronics Engineers
I/O	-	Input/Output
LAN	-	Local Area Network
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
MCC	-	Motor Control Center
NC	-	Normally Closed
NIC	-	Not In Contract
NO	-	Normally Open

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**BUILDING AUTOMATION SYSTEM**

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OWS/I.E	-	PC with standard web browser provided by others
OAT	-	Outdoor Air Temperature
PC	-	Personal Computer
RAM	-	Random Access Memory
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
RH	-	Relative Humidity
ROM	-	Read Only Memory
RTD	-	Resistance Temperature Device
SPDT	-	Single Pole Double Throw
SPST	-	Single Pole Single Throw
XVGA	-	Extended Video Graphics Adapter
TBA	-	To Be Advised
TCP/IP	-	Transmission Control Protocol/Internet Protocol
TTD	-	Thermistor Temperature Device
UPS	-	Uninterruptible Power Supply
VAC	-	Volts, Alternating Current
VAV	-	Variable Air Volume
VDC	-	Volts, Direct Current
WAN	-	Wide Area Network

## **1.6 REFERENCES**

- .1 All work shall conform to the following Codes and Standards, as applicable:

## **1.7 SUBMITTALS**

- .1 Shop Drawings, Product Data, and Samples
  1. The Building Management System contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.

## **1.8 RECORD DOCUMENTATION**

- .1 Operation and Maintenance Manuals
  1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the Building Management System provided:
    - .1 Table of contents.



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**BUILDING AUTOMATION SYSTEM**

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- .2 As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
  - .3 Manufacturers product data sheets or catalog pages for all products including software.
  - .4 System Operator's manuals.
  - .5 Archive copy of all site-specific databases and sequences.
  - .6 Network diagrams.
  - .7 Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.
- .2 On-Line documentation: After completion of all tests and adjustments the contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server

**1.9 WARRANTY**

- .1 Standard Material and Labor Warranty:
- 1. Provide a One-year labor and material warranty on the Building Management System.
  - 2. If within twenty-four (24) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the Building Management System Contractor at the cost of the Building Management System Contractor.
  - 3. Maintain an adequate supply of materials within 75 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during Building Management System Contractor's normal business hours.

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**BUILDING AUTOMATION SYSTEM**

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**1.10 ACCEPTABLE ALTERNATES**

- .1 Johnson Controls
- .2 Honeywell Controls
- .3 Siemens Controls

**PART 2 - PRODUCTS**

**2.1 GENERAL DESCRIPTION**

- .1 The Building Management System shall be by Schneider and the contractor shall be a Schneider dealer and use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the Building Management System shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
- .2 The Control and Building Management System shall consist of the following as required:
  - 1. Standalone capability with Network Control Unit connectivity
  - 2. Field Equipment Controller(s)
  - 3. Input/Output Module(s)
  - 4. Local Display Device(s)
  - 5. Portable Operator's Terminal(s)
  - 6. Distributed User Interface(s)
  - 7. Network processing, data storage and communications equipment capability
  - 8. Other components required for a complete and working Building Management System
- .3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- .4 Requirements and design is based on BACnet DDC system with adaptive and finite control for precise performance and operation; the system should be truly open standard BACnet over IP and MS/TP with built in interoperability at all levels and be capable of integrating 3<sup>rd</sup> party systems.
- .5 The approved BAS are Automated Logic, Alerton and Johnson Controls. No

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## BUILDING AUTOMATION SYSTEM

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other system will be accepted.

- .6 All DDC controllers and zone sensors should be BACnet Testing Laboratories (BTL) listed at the time of bidding. Include BACnet BTL listing and PICS statements at the time of tender.
- .7 The controls contractors shall indicate any exception to these specifications and drawings. In addition to base, alternated design may be proposed and shall indicate cost savings for consideration as alternate price.

## 2.2 BUILDING MANAGEMENT SYSTEM ARCHITECTURE

- .1 Provide Standalone DDC with LCD Display capable of supporting following Architecture for Building Automation Energy management and control systems for any future use. However, current DDC shall be completely standalone network with built-in capability of being monitored/operated over standard internet web browser.
- .2 Automation Network
  - 1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
  - 2. The Building Management System shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
  - 3. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
  - 4. Network Control Unit s (NCU) shall reside on the automation network.
  - 5. The automation network will be compatible with other local and wide networks. Where indicated, the automation network shall be connected to the WWW network and share resources with it by way of standard networking devices and practices.
- .3 Control Network
  - 1. Network Control Unit s shall provide supervisory control over the control network and shall support the following communication protocol:
    - .1 BACnet Standard MS/TP Bus Protocol or IP ASHRAE Standard 135-2001.

## BUILDING AUTOMATION SYSTEM

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2. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud at the terminal equipment controller level.
3. DDC Controllers shall reside on the BACnet/IP control network.
4. A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
5. The Conformance Statements shall be submitted 10 day prior to bidding.
6. The BAS devices residing on the enterprise network shall communicate over IEEE Standard Ethernet wire and be able to reside on any standard IT network with no special hardware.
7. All BAS server/workstation computers must meet the Region of Peel's desktop equipment specification as specified herein.
8. The use of ARCNET, Lonworks, RS-232 serial communications, or any other protocol for Controllers is not acceptable.

### 2.3 USER INTERFACE

#### .1 Dedicated Web Based User Interface

1. Where indicated on plans the Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the Network Control Units to facilitate greater fault tolerance and reliability.
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the Building Management System Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.
  - .1 Microsoft Internet Explorer for user interface functions
  - .2 Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
  - .3 Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
  - .4 Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.

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## BUILDING AUTOMATION SYSTEM

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### .2 Distributed Web Based User Interface

1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
2. The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser.

### .3 User Interface Application Components

1. Operator Interface
  - .1 An integrated browser based client application shall be used as the user operator interface program.
2. Schedules
  - .1 A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
    - Weekly schedules
    - Exception Schedules
    - Monthly calendars.
  - .2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
  - .3 It shall be possible to define one or more exception schedules for each schedule including references to calendars
  - .4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
  - .5 Changes to schedules made from the User Interface shall directly modify the Network Control Unit schedule database.
  - .6 Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
  - .7 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

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### BUILDING AUTOMATION SYSTEM

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3. Password
  - .1 Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
4. Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.
- .5 Dynamic Color Graphics
  1. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

## 2.4 DDC SYSTEM CONTROLLERS

- .1 DDC Controllers shall be 32 bit, multi-tasking, multi-user, real-time 133 MHz digital control processors consisting of modular hardware with Din mounted controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
- .2 Each DDC Controller shall support a minimum of 3 directly connected Secondary Networks. Each DDC Controller provided must be a "native" BACnet device, supporting the BACnet Advanced Application Controller (B-AAC) and shall be tested and certified by the BACnet Testing Laboratory (BTL).
- .3 Each DDC Controller shall have sufficient memory, a minimum of 72 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, and optional dial-up communications.
- .4 DDC Controller shall have an integral real-time clock.
- .5 Each DDC Controller shall support firmware upgrades without the need to change hardware.

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BUILDING AUTOMATION SYSTEM

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- .6 Each DDC Controller shall support:
  - 1. Monitoring of industry standard analog and digital inputs, without the addition of equipment outside the DDC Controller cabinet.
  - 2. Control of industry standard analog and digital outputs, without the addition of equipment outside the DDC Controller cabinet.
- .7 Spare Point Capacity:
  - 1. Each DDC Controller shall have a minimum of 10 percent spare point capacity.
  - 2. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than one spare of each implemented I/O type.
  - 3. Provide all processors, power supplies, and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the appropriate:
    - 1. Expansion modules
    - 2. Sensor/actuator
    - 3. Field wiring.
- .8 DDC Controllers shall provide at least one EIA-232C serial data communication ports for operation of operator devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals.
- .9 DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. All wiring connections shall be made to field-removable terminals.
- .10 Each DDC Controller shall continuously perform self diagnostics, communication diagnosis, and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication for any system.

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BUILDING AUTOMATION SYSTEM

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- .11 Power loss. In the event of the loss of power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.
- .12 Environment:
  - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
  - 2. Controllers used outdoors shall be mounted in an enclosure in a dry space and shall be rated for operation at temperature -40 to 70 degC.
  - 3. Controllers used in conditioned space shall be mounted in enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
- .13 Immunity to power and noise:
  - 1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
    - 1. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
  - 2. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
    - 1. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
    - 2. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
    - 3. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
    - 4. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)



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BUILDING AUTOMATION SYSTEM

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3. Isolation shall be provided at all DDC Controller's AC input terminals to suppress induced voltage transients consistent with:
  1. IEEE Standard 587 1980
  2. UL 864 Supply Line Transients
  3. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)
- .14 All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.
- .15 All digital points shall have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e. summer/winter).
- .16 Control Software Description:
  1. The DDC Controllers shall have the ability to perform the following pre-tested control algorithms:
    1. Two-position control
    2. Proportional control
    3. Proportional plus integral control
    4. Proportional, integral, plus derivative control
    5. Automatic tuning of control loops
- .17 DDC Controllers shall have the ability to perform any or all the following energy management routines:
  1. Time-of-day scheduling - up to a year in advance.
  2. Calendar-based scheduling.
  3. Holiday scheduling.
  4. Temporary schedule overrides.
  5. Start-Stop Time Optimization (automatically coordinated with TOD scheduling).
  6. Automation Daylight Savings Time Switchover.
  7. Night setback control.
  8. Enthalpy switchover (economizer).
  9. Peak demand limiting.
  10. Temperature-compensated duty cycling.

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BUILDING AUTOMATION SYSTEM

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- .18 DDC Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
1. A single process shall be able to incorporate measured or calculated data from any and all other DDC Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC Controllers on the network. Database shall support 30 character, English language point names, structured for searing and logs.
  2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
  3. DDC Controller shall provide a HELP function key. Enhanced context sensitive on-line help with task orientated information from the user manual.
  4. DDC Controller shall be capable of comment lines for sequence of operation explanation.
- .19 Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communication with other panels on the network.
1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
  2. The user shall be able to define the specific reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
  3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hours destinations) or based on priority.
  4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

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BUILDING AUTOMATION SYSTEM

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5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator devices.
20. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.
  1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples. All trend data shall be available for use in 3rd party personal computer applications (i.e. Microsoft® Excel, Lotus 123).
  2. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
    1. Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
- .21 DDC Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.
- .22 The peer-to-peer network shall allow the DDC Controllers to access any data from or send control commands to alarm reports directly to any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall send alarm reports to multiple workstations without dependence upon a central or intermediate processing device. The peer-to-peer network shall also allow any DDC Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.

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**BUILDING AUTOMATION SYSTEM**

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- .23 The peer-to-peer network shall allow the DDC Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

**2.5 NETWORK ROUTER CONTROLLERS**

- .1 Network Router Controllers (NRC) shall be classified as “native” BACnet devices supporting the BACnet Building Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NRCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-ACC).
- .2 Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile flash memory.
- .3 Each NRC shall provide communication to both workstations and field buses. An on-board 10/100bT Ethernet port shall be provided, as well as, a RS-485 port for communication to a maximum of 127 MS/TP devices.
- .4 Upon restoration of power after an outage the NRC 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.
- .5 The NRC shall include an on-board battery to back-up the NRC’s RAM memory. The battery shall provide accumulated back-up of all RAM and clock functions for at least 30 days.
- .6 The software shall be user programmable. This included all strategies, sequences of operation, control algorithms, parameters and set points. The source program shall be English language-based for the user. Controllers that use a canned programming method are not acceptable.

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**BUILDING AUTOMATION SYSTEM**

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**2.6 INPUT DEVICES**

**.1 General Requirements**

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

**.2 Temperature Sensors**

**1. General Requirements:**

- .1 Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- .2 The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
- .3 The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Chilled Water	+ .5°F.
Room Temp	+ .5°F.
Duct Temperature	+ .5°F.
All Others	+ .75°F.

**2. Room Temperature Sensors**

- .1 Room sensors shall be constructed for either surface or wall box mounting.
- .2 Room sensors shall have the following options when specified:
  - Setpoint reset slide switch providing a +3 degree (adjustable) range.
  - Individual heating/cooling setpoint slide switches.
  - A momentary override request push button for activation of after-hours operation.
  - Analog thermometer.

**3. Room Temperature Sensors with Integral Display**

- .1 Room sensors shall be constructed for either surface or wall box mounting.
- .2 Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
  - Display room and outside air temperatures.
  - Display and adjust room comfort setpoint.

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BUILDING AUTOMATION SYSTEM

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- Display and adjust fan operation status.
- Timed override request push button with LED status for activation of after-hours operation.
- Display controller mode.
- Password selectable adjustment of setpoint and override modes.

4. Thermo wells

- .1 When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
- .2 Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
- .3 Thermo wells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
- .4 Thermo wells shall be constructed of 316 stainless steel.

5. Outside Air Sensors

- .1 Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
- .2 Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
- .3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

6. Duct Mount Sensors

- .1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
- .2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

7. Averaging Sensors

- .1 For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

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BUILDING AUTOMATION SYSTEM

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- .2 For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
    - .3 Capillary supports at the sides of the duct shall be provided to support the sensing string.
  - 8. Acceptable Manufacturers: Johnson Controls, Setra.
- .3 Humidity Sensors
  - 1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
  - 2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 0-10V/4-20mA, 0-100% linear proportional output.
  - 3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
  - 4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
  - 5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
  - 6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
  - 7. Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.
- .4 Differential Pressure Transmitters
  - 1. General Air and Water Pressure Transmitter Requirements:
    - .1 Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

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BUILDING AUTOMATION SYSTEM

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- .2 Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
  - .3 Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
  - .4 A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
2. Low Differential Water Pressure Applications (0" - 20" w.c.)
- .1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
  - .2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - .01-20" w.c. input differential pressure range.
    - 0-10V/4-20mA output.
    - Maintain accuracy up to 20 to 1 ratio turndown.
    - Reference Accuracy: +0.2% of full span.
  - .3 Acceptable Manufacturers: Setra and Mamac.
3. Building Differential Air Pressure Applications (-1" to +1" w.c.)
- .1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
  - .2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - -1.00 to +1.00 w.c. input differential pressure ranges.  
(Select range appropriate for system application)
    - 0-10V/4-20mA output.
    - Maintain accuracy up to 20 to 1 ratio turndown.
    - Reference Accuracy: +0.2% of full span.
  - .3 Acceptable Manufacturers: Johnson Controls and Setra.
4. Low Differential Air Pressure Applications (0" to 5" w.c.)
- .1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.



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BUILDING AUTOMATION SYSTEM

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- .2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:  
(0.0 - 1.00" to 5.00") w.c. input differential pressure ranges.  
(Select range appropriate for system application.)
    - 0-10V/4-20mA output.
    - Maintain accuracy up to 20 to 1 ratio turndown.
    - Reference Accuracy: +0.2% of full span.
  - .3 Acceptable Manufacturers: Johnson Controls and Setra.
5. Medium Differential Air Pressure Applications (5" to 21" w.c.)
- .1 The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
    - Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
    - Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
    - Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
  - .2 Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
  - .3 Acceptable manufacturers: Johnson Controls and Setra.
- .5 Power Monitoring Devices
- 1. Current Measurement (Amps)
    - .1 Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 0-10V/4-20mA DDC compatible signal for use by the Facility Management System.
    - .2 Current Transformer – A split core current transformer shall be provided to monitor motor amps.
      - Operating frequency – 50 - 400 Hz.
      - Insulation – 0.6 Kv class 10Kv BIL.
      - UL recognized.

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BUILDING AUTOMATION SYSTEM

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- Five amp secondary.
  - Select current ration as appropriate for application.
  - Acceptable manufacturers: Veris Industries
- .3 Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
- 6X input over amp rating for AC intrushes of up to 120 amps.
  - Manufactured to UL 1244.
  - Accuracy: +.5%, Ripple +1%.
  - Minimum load resistance 30kOhm.
  - Input 0-20 Amps.
  - Output 0-10V/4-20mA.
  - Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
  - Acceptable manufacturers: Veris Industries

.6 Smoke Detectors

1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Mechanical Division. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System.

.7 Gas Monitor/Transmitter

1. The Gas Monitor/Transmitter is a microprocessor-based system for continuous effective monitoring f toxic and combustible gases. A 4-20 mA/0-10V output in proportion to the level of gas level present, and a factory calibrated DPDT alarm relay. A 10-step LED display in shall give a visual indication of the gas level in the atmosphere. Two types of sensing elements are available for most gases monitored. The highly accurate and very stable Type 1 sensors include catalytic gas sensors for many flammable gases and vapor concentrations, electrochemical cells for toxic gases, and diffusion fuel cells for oxygen sensing. The Type 2 solid-state sensors provide highly effective solutions for a wide range of applications. Use appropriate electrochemical sensors for NO2 and CO gases.

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## BUILDING AUTOMATION SYSTEM

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### .8 Status and Safety Switches

#### 1. Current Sensing Switches

- .1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- .2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- .3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
- .4 Acceptable manufacturers: Veris Industries

#### 2. Water Flow Switches

- .1 Water flow switches shall be equal to the Johnson Controls P74.

## 2.7 OUTPUT DEVICES

### .1 Actuators

#### 1. Electronic Valve Actuators

- .1 Electronic valve actuators shall be manufactured by the valve manufacturer.
- .2 Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
- .3 Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

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**BUILDING AUTOMATION SYSTEM**

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- .4 Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 0-10V/4-20mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
- .5 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
- .6 Acceptable manufacturers: Belimo, Honeywell, Johnson.

**2.8 MISCELLANEOUS DEVICES**

**.1 Local Control Panels**

- 1. All control panels shall be factory constructed, incorporating the Building Management System manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
- 2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
- 3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
- 4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
- 5. All wiring shall be neatly installed in plastic trays or tie-wrapped.

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**BUILDING AUTOMATION SYSTEM**

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6. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.
7. DDC / Control Panels should be NEMA 4 Type Enclosure.

**.2 Power Supplies**

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

**2.9 WEB-BASED OPERATOR INTERFACE**

- .1 The BAS shall be accessible via internet via the owner's existing Personal computer (PC) operator workstation server which shall provide for command entry, information management, system monitor, alarm management and database management functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater distribution, fault tolerance and reliability of the building automation control.
- .2 The browser-based interface must share graphical displays with the remote operator workstation(s) presenting dynamic data of site layouts, floor plans and equipment graphics. The browser's graphics shall support commands to change set points, enable/disable equipment and start/stop equipment. Through the browser interface operators must be able to navigate through the entire system and change the value or status of any point in any controller. Changes must be effective immediately to the controller with a copy stored in the system database.

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**BUILDING AUTOMATION SYSTEM**

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- .3 Through the browser interface, a live alarm viewer shall be provided should the operator's password allow it. The operator's must be able to receive alarms, silence alarms and acknowledge alarms through the browser.
- .4 Through the browser interface, operators must be able to change schedules, start/stop times and add new times to a schedule.
- .5 The system shall provide a web-based browser interface that allows technicians and operators to access graphics and stored data via the Internet, Extranet or Intranet. The server shall use Microsoft's IIS Server 6.0 with Windows Server 2014 or IIS 5.0 with Windows 2000 and support browser access via Microsoft Internet Explorer 6.0 (or higher) that is Java-enabled. The web-based user interface software must be capable of expansion for a minimum of ten concurrent users.

**2.10 APPLICATION SPECIFIC CONTROLLERS**

- .1 Each DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASC's) through floor level LAN device networks using BACnet MS/TP advanced application controller (B-ASC) device profile. ASC's shall be tested and certified by BACnet Testing Laboratory (BTL).
- .2 Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each TEC shall be a microprocessor-based, multi-tasking, real-time digital control processor.
- .3 Each ASC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.
  - 1. Provide for control of each piece of equipment, including, but not limited to, the following types:
    - 1. Heat Pumps
- .4 Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators. Terminal controllers utilizing proprietary control signals and actuators shall not be acceptable. As an alternative, provide DDC Controllers or other ASC's with industry standard outputs for control of all terminal equipment.

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**BUILDING AUTOMATION SYSTEM**

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- .5 Each controller performing space temperature control shall be provided with a matching room temperature sensor. The sensor may be either RTD or thermistor type providing the minimum performance requirements of +/- .6 deg. C accuracy, operating in the range of 2 to 46 deg.C , adjustable between 2 to 30 deg. C.
- .6 Each sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. The temperature indicator when required shall be an LCD display.
- .7 Each controller shall perform its primary control function independent of other DDC Controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during interruption is not acceptable. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications.
- .8 Provide each terminal equipment controller with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPRM, EPROM and PROM, or 72-hour battery

**PART 3 - EXECUTION**

**3.1 BUILDING MANAGEMENT SYSTEM Specific Requirements**

- .1 Graphic Displays
  - 1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
  - 2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .
- .2 Custom Reports:
  - 1. Provide custom reports as required for this project:

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BUILDING AUTOMATION SYSTEM

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**3.2 INSTALLATION PRACTICES**

**.1 Wiring**

1. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.
2. All wiring should be in EMT
3. Class 2 Wiring
  - .1 All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
  - .2 Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
4. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

**.2 Line Voltage Power Source**

1. 120-volt AC circuits used for the Control System shall be taken from panel boards and circuit breakers provided by Division 26.
2. Circuits used for the Building Management System shall be dedicated to the Building Management System and shall not be used for any other purposes.
3. DDC terminal unit controllers may use AC power from motor power circuits.

**.3 Penetrations**

1. Provide fire stopping for all penetrations used by dedicated Building Management System conduits and raceways.
2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.



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### BUILDING AUTOMATION SYSTEM

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3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

#### .4 Output Devices

1. All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
3. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.

### 3.3 TRAINING

- .1 The Building Management System contractor shall provide the following training services:
  1. On-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the Building Management System software layout and naming conventions, and a walk through of the facility to identify panel and device locations. Building Management System Contractor shall allow for a training session of 16 hours.

### 3.4 COMMISSIONING

- .1 Fully commission all aspects of the Building Management System work.

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**BUILDING AUTOMATION SYSTEM**

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**.2 Acceptance Check Sheet**

1. Prepare a check sheet that includes all points for all functions of the Building Management System as indicated on the point list included in this specification.
2. Submit the check sheet to the Engineer for approval
3. The Engineer will use the check sheet as the basis for acceptance with the Building Management System Contractor.

**.3 Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.**

**3.5 SEQUENCE OF OPERATIONS**

**.1 Exterior Lighting Control**

- .1 The exterior lighting system has been zoned and is provided with contactors for control (contactors by this Division).
- .2 Morality lighting (including building flood lighting) and Parking Lot Lighting shall have separate schedules).
- .3 The above zones shall be on time of day schedules. Provide a schedule for each zone. Lighting shall be off from 0:900 hours to 17:00 hours, regardless of photosensor signal.
- .4 Morality Lighting shall be enabled, subject to photosensor status, every evening from 17:00 hours until 09:00 hours the following day. (Operator adjustable)
- .5 Parking Lot Lighting shall be enabled, subject to photosensor status every week night from 17:00 hours until 24:00 hours. (Operator adjustable)
- .6 An exterior photometric sensor shall be monitored as a digital input point.
- .7 The BAS shall report an alarm if the photosensor senses light between 23:00 hours and 04:00 hours, or darkness between the 10:00 hours and 15:00 hours. This shall be an indication that either the photosensor is not working, or the BAS system clock is incorrectly set.

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BUILDING AUTOMATION SYSTEM

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- .8 Install "Hand-Off-Auto" switches so that exterior lighting can be conveniently tested and re-lamped during daylight hours by staff not conversant with BAS operation.
  - .9 The BAS shall monitor the status of the fire alarm system. If the fire alarm is active, subject to photo-sensor status, the BAS shall turn on all exterior lighting under its control, and leave it on four hours after the alarm is cleared.
- .2 Heat Recovery Units Control
- .1 Heat Recovery units is supplied complete with integral damper, factor prewired. Unit will include necessary dry contacts and control functionally to meet the following requirements for supervisory control from the BAS.
  - .2 Heat Recovery Unit shall be enabled/disabled based on time of day program, optimal start/stop and adjustable high and low limit setpoints through B.A.S. When unit is started, integral heat recovery unit controls shall operate.
  - .3 Unit shall be monitored for supply & return air temperatures and return air humidity from B.A.S. station. Unit shall also be monitored for leaving supply air temperature after heat recovery wheel and exhaust air temperature after heat recovery wheel.
  - .4 High or low supply and return air temperature conditions shall be alarmed at adjustable setpoint condition at B.A.S. station (i.e. 5°C before system shutdown).
  - .5 A low limit set at 7°C energized the electric heating coil on low temperature condition.
  - .6 Provide indication at B.A.S. for outside air, exhaust air, supply air, cooling coil temperatures, supply air humidity and Unit status and dirty filters.
- .3 Pump Control
- 1. The DDC system shall control and monitor the status of all HVAC and Domestic Hot Water pumps. Status of pumps shall be determined by a current transformer in conjunction with an AI point. Actual current draw in real time, expressed in amperes shall be available at the Operator Console. Connection to an auxiliary starter contact is not an acceptable alternative. Pump status shall be presented on the graphical display as an animation.

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BUILDING AUTOMATION SYSTEM

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- .4 Domestic Hot Water (Gas Fired System)
  - .1 The Building Automation System shall control the domestic hot water pump on Time of Day. The BAS shall monitor the status of the DHW pump by means of current transformers, and monitor the supply temperature.
- .5 Heat Pumps
  - .1 Each heat pump shall be controlled through a standalone intelligent DDC controller provided by the BAS Supplier and mounted on the heat pump cabinet, and a wall mounted intelligent electronic thermostat with programmable setpoint and mode override button, and no other features that will permit building occupants to interfere with the operation of the heat pump. Each stat to have jack in underside into which a palmtop computer can be plugged to access the entire system in text mode. See 23 81 40 "Heat Pumps Units" for full detail of control requirements. The thermostat shall have a limited temperature adjustment of 2 degrees up and down.
  - .2 The BAS controller shall operate through the heat pump manufacturer's terminal strip to control fan, compressor and reversing valve to maintain space temperature. The fan shall run continuously when in "Occupied" mode, and intermittently when in "Unoccupied" mode. Provide control transformers and power controller independently from heat pumps.
  - .3 The BAS controller will report any unit failure alarms generated by the heat pump's integral control system.
  - .4 Temperature setpoints will be limited to a reasonable range. The "reasonable range" of temperatures can be set at the Operator Work Station by a building operator with adequate password authorization.
  - .5 Upon receipt of an alarm from the heat pump, the DDC system shall generate a system alarm (and disable the heat pump, if this safety feature is not already built into the heat pump circuitry.)
  - .6 The BAS controller shall continuously monitor the supply air temperature.
  - .7 If the heat pump has been heating mode for at least 2 minutes, the BAS shall generate an alarm if the SAT is cooler than 30°C.
  - .8 If the heat pump has been cooling mode for at least 2 minutes, the BAS shall generate an alarm if the SAT is warmer than 18°C.

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BUILDING AUTOMATION SYSTEM

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- .9 The BAS Room Stat for the heat pump shall annunciate alarms generated by the local heat pump by flashing an LED continuously. Thermostat shall have the ability to set the temperature up or down by 2°C. Thermostat shall be able to override the unoccupied mode.
  - .10 The BAS shall calculate, on the basis of information updated at least once a minute, and present on a "Global Information" display:
    - a. Total number of heat pumps in occupied mode
    - b. Total number of heat pumps in override mode
    - c. Total number of heat pumps cooling
    - d. Total number of heat pumps heating
    - e. Total number of heat pumps in "alarm"
    - f. Average space temperature
    - g. Lowest space temperature
    - h. Average heating offset
    - i. Greatest heating offset
    - j. Average cooling offset
    - k. Greatest cooling offset
  - .11 Upon resumption of power after a power outage, restore operation of the heat pumps in sequence to minimize the heavy current draw that would otherwise take place. (See also the sequence for Resumption of Power.) If heat pumps have "Random Start" built into their integral controls, the BAS need not duplicate that feature.
  - .12 If the Heat Pump has a "Reset" terminal, it shall be possible to reset the integral heat pump alarms manually from the Operator Work Station.
- .6 Pump Loop Control

Heat Pump Loop Pumps shall operate in a lead/lag sequence with monthly rotation. One (1) pump shall be running at all times.

When flow is required in the heat pump loop, the BAS will activate the magnetic starter for the lead pump. Should pump motor not start-up and develop normal run amperage as detected by current transformer, or if flow is not proven by means of the flow switch within 20 seconds, the BAS shall disable the lead pump and activate the standby pump, and register an alarm. Should the flow not be proven within twenty seconds, the BAS shall register a "Critical Alarm".

(See Sequence for "Alarm Handling").

On loss of flow, start standby pump, deactivate all stages of control, report an alarm.

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### BUILDING AUTOMATION SYSTEM

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When flow is proven or restored, or in the event of restoration of power after a power interruption, the equipment shall be staged on to prevent a large current inrush. (See Sequence for "Resumption of Power").

Pressure switch in L.T. supply main shall control the VFD to maintain required flow.

#### .7 Heat Pump Loop Alarms

The BAS shall monitor the loop temperature at the two main headers. In the event that flow is not proven within 20 seconds of starting up the lag pump, the BAS shall report a "Critical Alarm", which includes activating the alarm strobe light in the administration area.

On a loop temperature fall to 1.7 degrees C (35°F), the BAS shall report a Critical Alarm.

On a loop temperature rise to 40.6 degrees C (105°F), the BAS shall report a Critical Alarm.

The BAS shall generate a graph for the return loop average hourly temperature on a daily basis and archives it for a five year period.

#### .8 Plumbing

.1 Totalize flow via pulse output reading from building water meter, make up water to storm retention system and water consumption through grey water supply meter. Water meters will be provided by Section 22 42 01. All levels shall be adjustable type to suit Building Operator's choice.

.2 Record solenoid open level, solenoid valve close level, pump off level and one spare (total of four) water levels of storm water cistern.

.3 Generate high and low levels alarm in storm water cistern.

.4 Weeper pit alarm thru contacts in pump controller.

.5 Building Automation System shall start and stop domestic water recirculation pump to suit time of day

#### .9 Unit Heaters

.1 Room temperature sensor shall modulate control units to maintain room temperature.

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BUILDING AUTOMATION SYSTEM

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.10 CO, NOX and Sulfur Dioxide Control

- .1 CO and sulfur dioxide and NOx sensors shall control exhaust fan and motorized damper to maintain proper levels.

.11 Resumption of Power

BAS controllers and front end will restart on resumption of power without human intervention.

In the event of a power outage, upon restoration of power, the BAS shall stage on controlled equipment to prevent power surges

Equipment and systems must be restored in a logical order. For example, in the case of a heat pump system, the pumps should be restored first after generator starts (0-5 minutes time delay adjustable), followed by the boiler or fluid cooler, and finally the heat pumps.

Wire to generator terminal strip dry contact for generator status.

The time between stages shall be sufficient to permit the first piece of equipment to startup, come up to speed, and settle down to drawing normal "run" amperage before starting up the next piece of equipment.

Specify in the shop drawing submittals the order in which controlled equipment shall be restored to normal operation after resumption of power.

.12 Alarm Handling

Alarm handling shall be a function of the DDC controllers, rather than the operator interface software, and the following functionality will be available in text mode without sound, even if the Operator Interface Software is running.

Alarms will be designated "Critical" or "Non Critical".

"Critical" alarms shall be registered for conditions that are serious enough to compromise the ability of the building systems to support normal business activities. Alarms should not be designated "Critical" unless they would justify having the building operator attend the site, or at least dial in to the site after hours.

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### BUILDING AUTOMATION SYSTEM

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“Non Critical” alarms shall be registered for conditions that lack that urgency.

“Critical” alarms are designated on the points list as “CR”, while “Non Critical” alarms are shown as digits.

In the event of a “Critical” alarm, the BAS shall

- .1 Indicate an alarm at the Operator Work Station (assuming that the OWS is turned on) both on the monitor and by voice message to the speakers.
- .2 Print out an alarm at the Operator Work Station (assuming that both OWS and printer are both turned on).
- .3 Dial out an alarm to the building operator’s pager.
- .4 Dial out an alarm to the BAS Contractor’s monitoring station, which in turn notifies the contractor’s duty technician.

In the event of a “Non Critical” alarm, the BAS shall

- .1 Indicate an alarm at the Operator Workstation (assuming that the OWS is turned on) both on the monitor and by voice message to the speakers.
- .2 Dial out an alarm to the BAS Contractor’s monitoring station.

If the OWS is not turned on at the time of the alarm, the alarm condition will be reported on the OWS monitor when the OWS is next activated.

#### .13 Assignment of Access Levels

- .1 Divide operator access to system into 3 basic levels of operation, programming and configuration of system. Each level requires unique access code and operator's initials to sign on.

Level 1 permits review of status and statistical data in panel being accessed. This includes status and value of points, totalized run time and trend data. Level 1 also allows operator to manually start and stop points and acknowledge alarms.

Level 2 provides operator with ability to perform level 1 functions, and display or modify application program data. Normally issued to senior board staff only, who have responsibility for energy costs.

Level 3 provides access to programming and safety logic, including limits on adjustment ranges, and will require high level access. Normally issued only to customer or contractor technicians certified by the manufacturer.



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**BUILDING AUTOMATION SYSTEM**

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- .2 Interface shall permit setpoint adjustment through graphics display using pulldown menus, mouse in conjunction with keyboard. Setpoint adjustments shall be password protected as follows:

Adjustment within limited range of nominal setpoint, low level password  
adjustment outside of limited range above, medium level password alarm  
setpoints, high level password.

Review of logs/status/system graphics shall be unprotected or low level  
password protected.

Programming, graphics display modifications shall be accessible only  
through medium/high level passwords as directed at system  
commissioning.

**3.7 POINT LISTS**

- .1 Each DDC shall have as minimum following I/O points types available. Controls Contractor shall provide all the points required to deliver compliant controls system. See attached Points List.

END OF SECTION



# **Electrical Specifications**

**City of Vaughan Fire Station No. 7 - 12**

**Project No. 2104  
JSC Project No. 21-237**

**Issued for Tender**

**Date: April 15, 2024**

**Prepared by:  
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TABLE OF CONTENTS

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CONTENTS

<u>SECTIONS</u>	<u>TITLE</u>
260100	Electrical General Requirements
260500	Electrical Basic Materials & Methods
260526	Grounding
260535	Telecommunication Raceway System
260800	Electrical System Commissioning
260923	Digital Metering
262401	Service
262416	Panelboards
262726	Wiring Devices
262823	Disconnect Switches
263300	Power Generator - Natural Gas
263623	Low Voltage Bypass/Isolation Automatic Transfer Switches
265000	Lighting Equipment
265200	Emergency Lighting System
283100	Fire Alarm System

---

ELECTRICAL GENERAL REQUIREMENTS

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
<u>PART 1 - GENERAL</u>	
1.1	Reference Sections
1.2	Intent
1.3	Definitions
1.4	By-Laws and Regulations
1.5	Permits and Fees
1.6	Examination of Site and Conditions
1.7	Contract Documents
1.8	Shop Drawings
1.9	Interference and Detail Drawings
1.10	Record Drawings
1.11	Operation and Maintenance Manual
1.12	Scheduling
1.13	Alternates and Substitutions
1.14	Valuation of Changes
1.15	Workmanship
1.16	Installation Requirements
1.17	Field Review
1.18	Temporary Services
1.19	Protection and Cleaning
1.20	Waste Management and Disposal
1.21	Mock-Ups and Trial Usage
1.22	Commissioning
1.23	Testing
1.24	Inspection
1.25	Testing, Verification & Integration of Life Safety Systems
1.26	Demonstration and Instruction
1.27	Warranty
1.28	Cash Allowance

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**ELECTRICAL GENERAL REQUIREMENTS**

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**PART 1 - GENERAL**

**1.1 REFERENCE SECTIONS**

- .1 Comply with the General Conditions, Supplementary Conditions of the Contract, and Section 26 01 00 – Electrical general requirements. Conform to Division 1, General Requirements and all documents referred to therein. Supplement with the following requirements.
- .2 This Specification Section is an integral part of the Contract Documents and shall be read accordingly. This Section applies to and is a part of all Sections of the Electrical Divisions 23 and 28.

**1.2 INTENT**

- .1 Mention in this Section or indication on the Drawings, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated and; performance of each operation prescribed with furnishing of necessary labour, equipment, tools, instruments, services and incidentals for the Electrical Division.
- .2 Sections of the Electrical Division are not intended to delegate functions nor to delegate work and supply to any specific trade and the work shall include all labour, materials, equipment, tools and inspection required for a complete and working installation as described.
- .3 The Specification Sections are integral with the Drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one, but included in the other is properly specified.
- .4 Wherever differences occur in the Contract Documents, the maximum conditions will govern and be allowed for in the Contract Price. The item to be incorporated will be at the option of the Consultant.

**1.3 DEFINITIONS**

- .1 Where used, words "Section" and "the Electrical Division" shall also include the Contractor and all Subcontractors engaged on the Site to perform the Work to make the Site complete in all respects.
- .2 Where used, word "connect" shall mean to supply and install all wiring and raceways and make all power connections to the Products.
- .3 Where used, word "supply" shall mean to include all labour, materials and services to furnish to site in location required or directed complete with accessory parts, but is not intended to include installation.
- .4 Where used, word "install" shall mean to include all labour, materials and services to secure in place Products, including receiving, unloading, transporting, storage, uncrating, installing, connecting and performance of such testing and finish the work as is compatible with degree of installation specified complete ready for use.

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## ELECTRICAL GENERAL REQUIREMENTS

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- .5 Where used, word "provide" shall mean to supply and install as each is described above.
- .6 Where used, word "commission" shall mean to startup and initial operation of the Products as required to demonstrate satisfactory operation of Products and entire system including calibration of any instrumentation.
- .7 Where used, wordings such as "approved, to approval, as directed, permitted, permission, accepted, acceptance, report to", shall mean "approved, directed, permitted, accepted, report to", by Consultant.

### **1.4 BYLAWS AND REGULATIONS**

- .1 Conform to latest Government, Provincial and Municipal By-laws, regulations, Codes and Standards and requirements of other authorities having jurisdiction in the area where work is to be performed. Minor changes required by the above authorities shall be carried out without change to the Contract Price. Standards established by the Drawings and Specifications shall not be reduced by the applicable codes or regulations.
- .2 Conform to the following applicable standards and regulations as minimum, but not limited to:
  - Canadian Standards Association (CSA) Standards
  - Underwriter's Laboratories of Canada (ULC) Standards
  - Ontario Electrical Safety Code (OESC) and Bulletins
  - Electrical Safety Authority (ESA) Requirements
  - Canadian Underwriters Association (CUA) Standards
  - Ontario Building Code (OBC)
  - National Fire Protection Association (NFPA) Standards
  - National Electrical Manufacturers Association (NEMA) Standards
  - Electrical and Electronic Manufacturers Association of Canada (EEMAC) Standards

### **1.5 PERMITS AND FEES**

- .1 Apply for, obtain, and pay for permits, licences, certificates, connection charges and inspections required by authorities having jurisdiction. Include any premiums applicable due to requirements for after office hours inspections.
- .2 The first submission of plans and specifications to ESA will be made by the Consultant. From then on, the Contractor shall be responsible for obtaining and complying with all the requirements of ESA.
- .3 Submit all required documentation to the authorities for their approval and comments before starting any work. Provide all additional drawings, details or information as may be required. Comply with any changes requested by the authorities as part of the Contract, but notify the Consultant immediately of such changes.

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**ELECTRICAL GENERAL REQUIREMENTS**

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**1.6 EXAMINATION OF SITE AND CONDITIONS**

- .1 Examine the Site and local conditions. Examine carefully all Drawings and complete Specifications to ensure that work and equipment will satisfy conditions and performance requirements as shown. Examine the work of Subcontractors responsible for the work of other Sections and report at once any defect or interference affecting the work, its completion or warranty. No allowance will be made later for any expense incurred through failure to make these examinations or to report any such discrepancies and omissions in writing..
- .2 Refer to the requirements of the Instructions to Bidders, paragraph 13 - Examination of the Place of the Work.

**1.7 CONTRACT DOCUMENTS**

- .1 The Contract Drawings of the Electrical Division are performance drawings and indicate the scope and general arrangement of the Work. They are diagrammatic except where specific details are given. They shall be read in conjunction with Architectural, Structural, Mechanical and all other Drawings of the Contract.
- .2 Obtain accurate dimensions from the architectural and structural Drawings, or by Site measurement. Locations and elevations of services are approximate and must be verified before construction is undertaken.
- .3 Make changes required to accommodate structural conditions, (beams, columns caps, etc.). Obtain the Consultant's approval before proceeding.
- .4 Adjust the location of materials and/or equipment up to 3 meters in any direction as instructed without adjustment to contract price, provided that the instructions are given before installation and rough-in.
- .5 The Drawings do not show all conduit and/or wiring or all structural, mechanical and architectural details. Plan and install conduit runs respecting all applicable conditions including structural, mechanical and architectural details.

**1.8 SHOP DRAWINGS**

- .1 Prepare and submit shop drawings of all Products in accordance with Division 1- General Requirements as specified in this Section and in each section of the Electrical Division.
- .2 Submit eight (8) copies of shop drawings. Shop drawings shall have a minimum 210 mm x 285 mm (8-1/2" x 11") clear space on the front sheet, suitable for stamping. The cover sheet shall include the project name, the Electrical Division and Section name and number and product description. Where multiple equipment is submitted under one binding, include an index of all equipment as the front sheet.
- .3 Assume full responsibility for submission of shop drawings. Allow minimum two (2) weeks for the Consultant's review.



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ELECTRICAL GENERAL REQUIREMENTS

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- .4 The Consultant will only review shop drawings bearing the Electrical Division and Section and Contractor's stamps of approval.
- .5 Submit shop drawings showing the following:
  - .1 Project name.
  - .2 Contract number.
  - .3 Manufacturer's name and model number.
  - .4 Supplier's name.
  - .5 Approval agencies.
  - .6 Shipping and working weight.
  - .7 Performance characteristics.
  - .8 Dimensions, including required clearances.
  - .9 Electrical characteristics.
  - .10 Bill of materials and finishes.
  - .11 Time required to fabricate and deliver.
  - .12 All variations from the Contract Documents.
  - .13 Construction and field connection details.
  - .14 Installation requirements.
- .6 The Consultant's review shall not relieve the Contractor of responsibility to provide Products in accordance with the design intent and Contract Documents.
- .7 Manufacturer's printed data sheets for standard items are acceptable providing pertinent characteristics are identified and relate to specified items.
- .8 Each shop drawing shall be checked and stamped as being correct, by Subcontractors purchasing item, and by the Contractor, before drawing is submitted. If the above requirements are not complied with, shop drawings will be rejected and returned forthwith.
- .9 Where applicable, provide wiring details, schematics, single line drawings, and wiring diagrams showing interconnection with the work of other Specification Sections.
- .10 Verify and check dimensions to ensure proper installation of equipment in available space and without interference with the work of other Sections. Ensure that electrical and all other coordination is complete prior to submission of shop drawings.
- .11 Provide data sheets and samples for all wiring devices and wall plates prior to installation. Device and plate colours/finishes to be confirmed prior to ordering.
- .12 Where requested, submit samples of the Products for review and approval.
- .13 Do not have equipment delivered to Site until a shop drawing for the item has been reviewed.

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## ELECTRICAL GENERAL REQUIREMENTS

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### 1.9 INTERFERENCE AND DETAIL DRAWINGS

- .1 Prepare interference drawings in conjunction with all parties concerned showing sleeves and openings and passage of piping and conduits through building structure. Drawings shall also show inserts, curbs, equipment bases, anchors, special hangers and weights on all load points.
- .2 Prepare fully dimensioned detail drawings of products and services in electrical rooms, service and ceiling spaces, and all other critical locations. Co-ordinate the work of the Electrical Division with the work of Mechanical Divisions (ie. 21, 23 and 25) Base drawings on reviewed shop drawings and indicate all details pertaining to access, clearances, sleeves, electrical connections, and elevations of pipes, ducts and conduits. Include location of access doors provided under the Electrical Division.
- .3 Ensure that clearances required by jurisdictional authorities are indicated on the interference drawings. The Owner will not consider any extra cost as a result of the Contractor's failure to prepare proper interference drawings.

### 1.10 RECORD DRAWINGS

- .1 Conform to Division 01 - General Requirements. Maintain at least two sets of documents and clearly mark on same as job progresses, changes and deviations from the work shown so that on completion the Owner will have records of exact location of ducts and equipment and record of material and equipment changes.
- .2 The Contractor shall obtain clean set of prints from the Consultant at start of the Contract Work and shall keep these prints up-to-date at the Site, accurately recording all changes made on project and locating all services, equipment, etc. which may have been shown only diagrammatically on the Contract Documents.
- .3 The Contractor shall ensure that as-built information is accurately recorded and shall check same. As-built drawings shall be reviewed with the Consultant at each Site meeting.
- .4 Prepare record drawings showing the following:
  - .1 Inverts of all services entering and leaving the building and at property lines.
  - .2 Dimensions of underground services in relation to property lines at key points of every run.
  - .3 Elevations of underground services in relation to ground floor level of the building.
  - .4 Location of all services embedding in the structure, utilizing grid line references.
  - .5 Dimensioned locations of all services left for future work.
  - .6 All changes to the Work due to Change Orders and Site Instructions.
  - .7 All changes to the Work during construction.
  - .8 All changes to structural and architectural elements that affect the backgrounds of this record set.

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### ELECTRICAL GENERAL REQUIREMENTS

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- .9 Location and designation of all electrically supervised valves, flow switches and pressure switches.
  - .10 Location and designation of all items requiring access or service in a hidden location.
  - .11 Location of all access doors provided under the Electrical Division.
  - .12 All changes and revisions to Specifications, details and equipment schedules.
  - .13 All homerun conduits, junction boxes for complete electrical systems.
- .5 Upon completion of Contract Work, prior to Substantial Performance inspection and after final review with Consultants, Contractor shall issue to the Consultant for review the actual on site As-Built Drawings. Upon acceptance Contractor shall neatly transfer recorded information and make final As-Built submission to Consultant for review in the following form:
- One (1) set of clean, legible prints.
  - One (1) ACAD (latest version) format drawings. Files shall retain all setting (layers, line types, scales colors, etc) as used in the drawing files (produced) by consultant.
- .6 After Record Drawings have been reviewed, revised if necessary until acceptable to the consultant. Deliver drawings in the form of CD (CAD + PDF) and three (3) sets of prints taken from that CD to Owner.

#### 1.11 OPERATION AND MAINTENANCE MANUAL

- .1 The Contractor will be responsible for collecting and organizing three (3) copies of all data, operating instructions, maintenance and trouble-shooting instructions, parts lists, parts diagrams, evidence of all tests and certifications, complete reviewed shop drawings, etc. and assembling them in neat manuals in hard cover. Identify cover "Operation and Maintenance Manual for NAME OF THE PROJECT". Manuals shall be separated with dividers in logical sections and volumes.
- .2 The Contractor shall also collect from Subcontractors and Suppliers all guarantees/warranties specified in the Contract Documents. Ensure that all guarantees/warranties provided comply with the requirements of Article A-6 of the Articles of Agreement and extent of each guarantee/warranty are clearly indicated. Check also that all guarantees/warranties indicate Supplier's Name or Subcontractor's Name as appropriate together with contact phone number. Assemble neatly in labeled section of each manual.
- .3 Prior to applying for Substantial Performance of the Work, submit one (1) copy to Consultant for review. Make all corrections requested by the Consultant and forward the corrected two (2) copies to the Owner.

#### 1.12 SCHEDULING

- .1 Comply with the approved construction schedule. Conform to phasing of work if applicable. Conform to interim and final completion dates.
- .2 Co-ordinate electrical schedule with general construction schedule.

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## ELECTRICAL GENERAL REQUIREMENTS

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- .3 Submit a bar chart schedule showing the start and completion dates for each activity based on a critical path analysis of the work.
- .4 Include in schedule for electrical work done by others, e.g. Power Supply Authority connection.

### **1.13 ALTERNATES AND SUBSTITUTIONS**

- .1 Refer to Section 01 61 00 – Common Product Requirements for the Product Substitution Procedures.
- .2 It is the responsibility of this Division to ensure "Substitute Products" fits space allotted and gives performance specified.
- .3 If Products manufactured and/or specified by a manufacturer named as equivalent are used in lieu of the manufacturer specified, be responsible for ensuring that the substituted Product is equivalent in performance and operating characteristics to the specified Product, and, it shall be understood that all costs for additional space, larger power feeders and changes to associated or adjacent work will be borne by the Contractor offering the substitution. In addition, in Equipment Rooms where Products named as equivalent is used in lieu of specified Products and the dimensions of such Products differs from the specified Products, prepare and submit for approval, accurately dimensioned layouts of rooms affected.
- .4 The Contractor shall be responsible for all additional costs incurred as a result of the review and use of Substitute Products.

### **1.14 VALUATION OF CHANGES**

- .1 For each change submit a complete itemized breakdown of labour and material.
- .2 Only the net difference between an extra and a credit will be subject to overhead and profit mark-up.
- .3 Material shall be valued at current trade prices incorporating all discounts and labour rates.

### **1.15 WORKMANSHIP**

- .1 Workmanship and method of installation shall conform to best standards and practice and be performed to approval. Work shall be done by the Contractor or Subcontractor skilled in work to be performed. Where required by local or other Bylaws and Regulations, the Contractor or Subcontractors shall be licensed in their trade. Install all work and equipment to manufacturer's printed directions.

### **1.16 INSTALLATION REQUIREMENTS**

- .1 Coordinate the work of the Electrical Division with the work of other Divisions (ie. 21, 23 and 25). Inform other Divisions (ie. 21, 23 and 25) of the locations of openings, chases, sleeves, supports, services, connections, etc., to be incorporated into the work of the Electrical Division.

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### ELECTRICAL GENERAL REQUIREMENTS

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- .2 Check the locations of all expansion/building joints and ensure that all electrical installations are at or crossing these locations are as detailed and as required to compensate for the possible movement at the joint.
- .3 Confirm the exact location of outlets, fixtures and connections. Check architectural details and elevations for more requirements. Confirm location of connection points for equipment supplied under other Sections or by the Owner.
- .4 Install neatly all equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
- .5 Install metering and/or sensing devices to provide accurate and reliable sampling of quantities being measured. Install instruments to permit easy observation.
- .6 Provide suitable shielding and physical protection for devices.
- .7 Install all Products and services in accordance with the manufacturer's requirements and/or recommendations.
- .8 Provide all supports, hangers and fasteners. Secure all Products and services so as not to impose undue stresses on the structure and systems.
- .9 Ensure that the load onto structures does not exceed the maximum loading per square meter (foot) as shown on structural drawings or as directed by the Consultant.
- .10 Do not use explosive activated tools.

#### **1.17 FIELD REVIEW**

- .1 The Owner and Consultant shall have access to the Site at all times for review of the work during construction.
- .2 Arrange for review of the Products during manufacturing.
- .3 Provide all gauges, instruments and other necessary measuring equipment required for review of the Work.
- .4 Maintain a complete set of the Contract Documents at all times for field reference by the Consultant.
- .5 Correct any deficiencies as they are reported during the performance of the work.

#### **1.18 TEMPORARY SERVICES**

- .1 Provide temporary office, workshop and tools and material storage space for the work and assume responsibility for any loss or damage thereto. Buildings erected for this purpose shall conform in appearance to those erected for similar purposes under other Specification Sections.
- .2 Provide temporary lighting for the Site. Coordinate with the Consultant for requirements.

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### ELECTRICAL GENERAL REQUIREMENTS

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- .3 Provide scaffolding and shoring necessary for the work of the Electrical Division. Scaffolding and shoring shall be adequate to protect the workmen according to provincial and local regulations.
- .4 Provide rigging and millwrighting, labour and equipment necessary for the work of the Electrical Division. Employ only workmen well experienced and skilled in such trades for this portion of the work.
- .5 Provide hoisting machinery, operators, labour and materials necessary to lift and place equipment supplied under the Electrical Division.
- .6 The permanent systems or any part thereof shall not be used during construction for construction purposes, unless so permitted by the Owner, in writing.

#### **1.19 PROTECTION AND CLEANING**

- .1 Securely plug or cap open ends of electrical raceways or equipment to prevent entry of dirt, dust, debris, water, snow or ice.
- .2 Equipment stored on site shall be protected from weather and kept dry and clean at all times. Take care to avoid corrosion of metal parts.
- .3 Protect all finished and unfinished work of the Electrical Division and the work of other Specification Sections from damage due to carrying out of this work.
- .4 Make good any damage caused directly or indirectly to walls, floors, ceilings, woodwork, brickwork, finishes, etc.
- .5 Before energizing any systems, inspect and clean the inside of all panelboards, switchgear and cabinets to ensure that they are completely free from dust and debris.
- .6 Clean all polished, painted and plated work. Clean all lighting fixtures. Remove all debris, surplus material and tools.
- .7 Carry out additional cleaning operations of systems as specified in all Sections of the Electrical Division and in Division 01 – General Requirements.

#### **1.20 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials.
- .2 Divert unused wiring and metal materials to metal recycling facility, or place in appropriate on-Site bins for recycling in accordance with the Consultant's requirements.

#### **1.21 MOCK-UPS AND TRIAL USAGE**

- .1 Provide mock-ups in accordance with the conditions stated in Division 01 – General Requirements.

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## ELECTRICAL GENERAL REQUIREMENTS

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- .2 Trial usage of any equipment or materials shall not be construed as evidence of acceptance of same and no claim for damage shall be made for injury to or breaking of any part of such work which may be so used.

### 1.22 COMMISSIONING

- .1 Be responsible for commissioning of all work provided under the Electrical Division. The total commissioning requirements of the Electrical Division involve:
  - .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 Secondary switchgear.
  - .2 Generator.
  - .3 Transformers.
  - .4 Lighting and power distribution.
  - .5 Fire alarm systems.
  - .6 Emergency lighting system.
  - .7 Electric heating equipment/system.

### 1.23 TESTING

- .1 Carry out all tests specified and tests required by the Ontario Building Code, Electrical Safety Authority and local fire department. The testing and adjusting is the responsibility of Divisions 26 and 28.
- .2 Provide all equipment, labour, instruments, expenses of the manufacturer's representative, and incidentals, and pay for all power and fuel required to carry out the tests.
- .3 Submit the record of all tests and have these tests signed by the Contractor and, where applicable the manufacturer's representative. Show in schedule form a record of the systems or parts of systems tested, the date of the test, the circumstances such as current, temperatures, etc., the duration of the test and any special remarks pertaining to events during the test. Note which tests have been witnessed by the Ontario Building Code, Electrical Safety Authority and local fire department.
- .4 Submit certification letters from the manufacturers of all equipment certifying that their technical representatives have inspected and tested their equipment and are satisfied with the methods of installation and operation. Where existing systems are extended, provide letters covering both new and existing equipment and connections. These letters shall state the names of persons present at testing, methods used and a list of functions performed with location and room numbers where applicable.

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**ELECTRICAL GENERAL REQUIREMENTS**

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**1.24 INSPECTION**

- .1 Arrange for inspection of the work by the Ontario Building Code, Electrical Safety Authority and local fire department. On completion of the work furnish final unconditional certificates of approval by the inspection authorities.
- .2 Application for final review will be considered when the work has been completed and written declarations submitted that all commissioning, testing adjustment, set up and documentation is complete. Final review shall be done when:
  - .1 All reported deficiencies have been corrected.
  - .2 All systems have been balanced, tested, commissioned and are operational.
  - .3 The Owner has been instructed in the operation and maintenance of all equipment.
  - .4 All reports have been submitted and reviewed.
  - .5 All maintenance manuals have been submitted and reviewed.
  - .6 All tags and nameplates are in place and all data submitted and reviewed.
  - .7 Cleaning up is finished in all respects.
  - .8 All certificates are furnished.
  - .9 All spare parts and replacement parts specified have been provided.
  - .10 All record drawings have been submitted and reviewed.

**1.25 TESTING, VERIFICATION & INTEGRATION OF LIFE SAFETY SYSTEMS**

- .1 All life safety systems integrated with the fire alarm system must be verified and documented in accordance with O.B.C. 3.2.10.1 and the latest edition of CAN/ULC-S1001-11, "Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems". The following is to be prepared and submitted by the Electrical Contractor and signed by a P.Eng. to the Consultant for review at the start of the project:
  - .1 Integrated Testing Plan – A written specific document prepared by the Integrated Testing Coordinator, outlining the required tests and necessary functional results to conduct integrated fire protection and life safety systems testing.
  - .2 Integrated Testing Report – A written project specific document, prepared by the Integrated Testing Coordinator, documenting the implementation of the integrated testing plan.
  - .3 The following systems (where applicable) are to be integrated into the Testing Plan and Testing Report:
    - .1 Fire Alarm System (including Sequence of Operation)
    - .2 Mass Notification System
    - .3 Elevators
    - .4 Emergency Generators
    - .5 Audio/Visual System
    - .6 Lighting Control System
    - .7 Notification Systems



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**ELECTRICAL GENERAL REQUIREMENTS**

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- .8 Fire Protection System including Sprinkler System, Standpipe, etc.
- .9 Freeze Protection Systems
- .10 Fire Suppression Systems
- .11 Smoke Control Pressurization Systems
- .12 Smoke Control Smoke Exhaust Systems
- .13 Hazardous Protection Monitoring
- .14 Smoke Alarms
- .15 Nurse Call System
- .16 Other System (where applicable)

**1.26 DEMONSTRATION AND INSTRUCTION**

- .1 Provide personnel, equipment and tools to demonstrate and instruct the Owner's designated personnel in operation, controlling, adjusting, trouble-shooting and servicing of all systems and equipment to satisfaction of the Owner. This work shall take place during the Owner's regular business hours prior to acceptance.
- .2 Where specified elsewhere in the Electrical Division, The Contractor shall ensure that manufacturers provide demonstration and instructions.
- .3 Where deemed necessary, the Consultant or Owner may record these demonstrations via video tape or other means for future reference.

**1.27 WARRANTY**

- .1 Provide a written guarantee stating that systems, equipment, components, etc. have been installed to manufacturer's instructions, that systems meet the Contract requirements and that all deficiencies in material and labour occurring within one year after substantial completion, will be corrected at no charge.
- .2 Obtain the Product warranties in excess of one (1) year from the manufacturer on behalf of the Owner. These Product warranties shall be issued by the manufacturer to the benefit of the Owner.
- .3 Instruct all manufacturers and suppliers that warranties on the Products will commence in accordance with Article A-6 of the Articles of Agreement and not from the date the Products are put into operation.
- .4 All corrections to deficiencies listed in field review reports and other correspondence, as well as but not limited to those indicated in testing, adjusting, balancing and commissioning shall be completed prior to turn over.

**1.28 CASH ALLOWANCE**

Refer to Division 01 for more information.

**END OF SECTION**

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BASIC MATERIALS AND METHODS

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CONTENTS

SUBSECTION      TITLE

PART 1 - GENERAL

1.1	Summary
1.2	Submittals
1.3	Products

PART 2 - PRODUCTS

2.1	Electrical Identification
2.2	Wires and Cables
2.3	Raceways and Fitting
2.4	Outlet and Conduit Boxes
2.5	Contactors
2.5	Access Panels and Doors
2.6	Sprinkler Proof Equipment
2.7	Backboards
2.8	Metals
2.9	Sleeves and Curbs
2.10	Supports and Bases
2.11	Spare Parts
2.12	Cord Reel Receptacles

PART 3 EXECUTION

3.1	Neutrals and Phasing
3.2	Mounting Heights
3.3	Wiring of Mechanical Equipment
3.4	Services to Equipment Supplied By Owner / Other Divisions
3.5	Provision for Future Equipment And Construction
3.6	Cutting and Patching
3.7	Painting
3.8	Vibration and Noise Control
3.9	Concrete
3.10	Excavation and Backfilling
3.11	Concrete Encased Duct Banks

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BASIC MATERIALS AND METHODS

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**PART 1 - GENERAL**

**1.1 SUMMARY**

- .1 Comply with General Conditions, Supplementary Conditions, and section 26 01 00 – Electrical General Requirements.
- .2 The work of this Section includes furnishings of labour, materials, and equipment required for installation, testing and putting into proper operation complete electrical systems as shown, as specified and as otherwise required by the Contract Documents. Complete systems shall be left ready for continuous and efficient satisfactory operation.

**1.2 SUBMITTALS**

- .1 Submit shop drawings and product data for products specified in this Section in accordance with Section 26 01 00 – Electrical General Requirements.

**1.3 PRODUCTS**

- .1 Products shall be new, of Canadian manufacture where available, first quality and uniform throughout. Submit tender based on the use of products and equipment specified, or on the listed acceptable alternate equipment as further detailed.
- .2 Electrical products shall be C.S.A. approved and be so labeled. Products not CSAC.S.A. approved shall receive acceptance for installation by Ontario Hydro Special Inspections Branch before delivery, and modifications and charges required for such acceptance shall be included in work of this Section. Products shall not be installed or connected to the source of electrical power until approval is obtained.
- .3 Where the manufacturer is not specified, provide products of high commercial standard and quality consistent with the standards of these specifications. Provide products of same manufacture for like applications unless noted otherwise.
- .4 Products shall be designed and manufactured in accordance with latest issue of applicable standards or authorities having jurisdiction when such are either mentioned herein, or have jurisdiction over such materials or items of equipment. Confirm capacity, ratings and characteristics of products being provided to supply power to equipment provided under other Sections of the work. Resolve discrepancies before such items are purchased.
- .5 Acceptance of products installed presumes that products have not been damaged or exposed to conditions that would adversely affect performance and life expectancy. If in the opinion of the Consultant, products have sustained damage, or have been exposed to abnormal conditions it shall be the responsibility of the Contractor to have such tests performed as deemed necessary by the Consultant to establish condition and therefore, acceptability of installed products.

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BASIC MATERIALS AND METHODS

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**PART 2 - PRODUCTS**

**2.1 ELECTRICAL IDENTIFICATION**

- .1 Outlet boxes
  - .1 Identify outlet boxes on the box cover with: circuits contained in the box, the panels from which they are fed, the voltage and purpose of the outlet.
- .2 Cable and conduit
  - .1 Identify conduits and cables for the various systems by the use of the following distinctive coloured labels. The labels shall comprise pressure sensitive plastic tape with printing labels indicating the system. Apply a small area of paint to the outside and inside of each outlet box, pull box and panel as it is being installed. Identify junction boxes in suspended ceiling areas with colour on both inside and outside.
    - .1 120/208 volt system – yellow
    - .2 347/600 volt system – white
    - .3 Emergency power - orange
    - .4 Fire alarm systems – red
    - .5 Data cabling system – blue
    - .6 P.A./Telephone systems – grey
    - .7 Security/Intercom/CATV systems – black
    - .8 Other telecommunication systems - green
  - .2 Locate identification labels at follows:
    - .1 Behind each access.
    - .2 At each change of direction, at junction boxes, and at both ends of each run.
    - .3 At not more than 15m apart in straight runs.
    - .4 Where passing through a wall, partition, and floor. One on each side of wall, partition, and floor.
- .3 Cable and conduit labels
  - .1 For power and lighting system feeders, install labels at either end of the conductors where terminated inside of equipment to match wiring diagram conductor identification or panelboard circuit numbers. Typical identification Panel AA circuit - 21; use "AA-21". For a three phase circuit, provide identification on phase A conductor only. For a single phase circuit, provide identification on the phase conductor.
  - .2 For lighting branch circuits, identify circuit at panel and in outlet box connection to lighting fixture. Install label on phase conductor tap-off. Typical identification if fixture connected to Panel A, circuit 5; marker identification A-5.

#### BASIC MATERIALS AND METHODS

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- .3 For branch circuits supplying single phase and three phase devices such as receptacles and connections to equipment identify conductors at panel and in device outlet box. Install label on phase conductor inside outlet box. Typical identification if device is connected to Panel B - circuit 14, marker identification "B-14".
- .4 For switchboards, identify all control conductors at terminal strips inside equipment and where terminated at all remote devices. Identification shall match numbering system on the Drawings and "Reviewed" shop drawings.
- .5 For fire alarm systems, identify all conductors at terminal strips located in:
  - .1 Control panels.
  - .2 Annunciators.
  - .3 Printers.
  - .4 Local terminal cabinets.
  - .5 All remote devices.
  - .6 All connections in the system.
  - .7 Provide identification in accordance with the numbering system on the "Reviewed" shop drawings.
- .6 For miscellaneous systems identify all conductors at terminal strips located in:
  - .1 Control and/or monitoring panels.
  - .2 Control and/or monitoring stations.
  - .3 Local terminal cabinets.
  - .4 All remote devices.
  - .5 All connections in the system.
  - .6 Provide identification in accordance with the numbering system on the "Reviewed" shop drawings.
- .4 Equipment nameplates
  - .1 Provide lamaroid name plates, black background with white engraved letters 0.4" (10 mm) high, for electrical equipment but not limited to panels, switchboards, transformers, disconnect switches, breakers, contactors, relay panels, starters, TVSS, FACP and miscellaneous panels.
  - .2 Nameplates shall indicate voltage, capacity, upstream, and downstream equipment Typical identification for panel: "Lighting Panel C, 120/208 v, 3 phase, 4 W. Supplied from Panel BB".
  - .3 Switchboards - Plates to be mounted on face of switchboards. Typical identification for switchboard: "Switchboard AAA - 120/208 V, 3 phase, 4 W". Typical identification for branch feeders: "Power Panel BB".
  - .4 Install plates after all painting has been completed. Secure with mechanical fastening devices except on the inside of panel doors where gluing will be acceptable.

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BASIC MATERIALS AND METHODS

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- .5 Power system colour code
  - .1 Power system phase colour code:
    - .1 Red - Phase A
    - .2 Black - Phase B
    - .3 Blue - Phase C
    - .4 Neutral - White
    - .5 Ground - Green.
  - .2 Identify incoming utility service lines with enamel paint to above colour code.
  - .3 Band buses in switch board and panels to above colour code.
  - .4 Provide branch conductor to above colour code.
- .6 Manufacturer's nameplates
  - .1 Have the manufacturer's nameplates affixed to each item of all equipment showing the size, name of equipment, serial number and all information usually provided, including voltage, cycle, phase, horsepower, etc., and the name of the manufacturer and his address. Ensure that all stamped, etched or engraved lettering on plates is perfectly legible. Ensure that nameplates are not painted over. Where apparatus is to be concealed, attach the nameplate in an approved location on the equipment support or frame.
  - .2 Ensure that panels and other apparatus which have exposed faces in finished areas do not have any visible trade marks or other identifying symbols. Mount nameplates behind doors.
- .7 Signage and marking
  - .1 Provide signage to local inspection authority on all equipment and electrical rooms.
  - .2 The suitable warning signs must be installed in accordance with the Electrical Safety Code.
  - .3 Where applicable, provide warning signs for ground fault protection circuit as required by OESC, section 68-068.
  - .4 Where applicable, provide warning signs and marking for the power disconnect switches for fire pumps in accordance with NFPA-20, section 9.3.
- .8 Single line distribution drawings
  - .1 Provide clear acrylic covered framed as-built single line distribution system drawing of the entire project in the main electrical room. Distribution system shall be CAD generated. Size shall be minimum 305 mm x 460 mm with all text legible. Provide interim drawings until such time that permanent as-built drawings are available for permanent installation.

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**BASIC MATERIALS AND METHODS**

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**2.2 WIRES AND CABLES**

- .1 Comply with the requirements of the latest editions of the followings:
  - .1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
  - .2 CAN/CSA-C22.2 No.131 – Type TECK 90 Cable.
  - .3 CSA C22.2 No. 38, Thermoset Insulated Wires and Cables.
  - .4 CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables
  - .5 CSA C22.2 No. 65, Wire Connectors.
- .2 Use copper conductors TWH, 600V, 90°C rated insulation unless otherwise noted.
- .3 Use RW90 X-Link, 1000V, minus 40 degree, 90°C rated insulation for 250MCM and larger.
- .4 Joints in feeder cables are not permitted.
- .5 Except as indicated hereinafter, wire for branch circuits to be #12 AWG except that #10 minimum to be used where the home run exceeds 27m (90').
- .6 Wires for power circuits shall be #12 AWG minimum, and for control circuits shall be #14 AWG minimum.
- .7 Solid conductors for #12AWG and smaller. Stranded conductors for #10 AWG and larger.
- .8 For wiring through or in lighting fixtures, use type 'GTF' fixture wire, rated 600 volts to meet Ontario Electrical Safety Code (OESC) requirements for recessed fixtures.
- .9 Wire to ceiling outlet boxes on which a lighting fixture is or may be mounted, with conductors having insulation suitable for 90°C.
- .10 Cables located in plenum, ceiling or floor spaces shall be totally enclosed in non-combustible conduit or raceway or be armoured cable where permitted by the Ontario Building Code.
- .11 Wires and cables for outdoor locations shall be minus 40°C rated.
- .12 Armoured cables shall be complete with interlocked aluminum armour, approved fastening and connectors and meet the requirements of Vertical Flame Test-Cables in Cable Tray of CSA C22.2 No. 0.3. The PVC jacket cables (TECK 90 and ACWU90) shall be FT6 rated.
- .13 Install all wiring in conduit, unless indicated as armoured. Route wire and cable to meet Site conditions. Use suitable cable fittings and connectors.
- .14 Use an approved lubricant to assist in pulling conductors through conduit. Neatly train and lace wiring inside boxes, equipment and panelboards.
- .15 Balance the loading on feeders so that unbalanced load is less than 10%.
- .16 Limit the voltage drop at the end of feeders and branch circuits to 2% at the rated load of the circuit.

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**BASIC MATERIALS AND METHODS**

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- .17 For single conductor armoured cables, where required to conform to the Electrical Safety Code, Rule 12-108, Bulletin 12-7-11.
- .18 Lighting fixture wiring in accessible ceiling spaces shall be run in conduit from the lighting panel to ceiling outlet boxes with armoured cable drops no longer than 3.0m (10 ft.) permissible from the boxes to fixtures.
- .19 Protect all exposed non-armoured cables in manholes, pull pits and trenches with an approved fire protective fibreglass tape of '3M' manufacture or approved equivalent. Extend the protective wrapping on the cables where they leave pull pits or trenches below switchgear to the circuit breaker or fused switch terminals. Rack cables in manholes and pull pits to provide clear access for maintenance and servicing.
- .20 BX may be used in hollow partitions for receptacles.

**2.3 RACEWAYS AND FITTING**

- .1 Drawings do not show all raceways. Those shown are generally in diagrammatic form only.
- .2 Conform with the requirements of the latest editions of the following:
  - .1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  - .2 CSA C22.2 No. 45, Rigid Metal Conduit.
  - .3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4 CSA C22.2 No. 62, Surface Raceways and Lighting Fixture Raceways and Fittings.
  - .5 CSA C22.2 No. 83, Electrical Metallic Tubing.
  - .6 CSA C22.2 No. 126, Cable Tray System.
  - .7 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.
  - .8 CAN/CSA C22.2 No. 227.3, Flexible Non-metallic Tubing.
  - .9 CSA C22 No. 18, Outlet Boxes, Conduits Boxes, Fittings and Associated Hardware.
- .3 Conduits
  - .1 Rigid steel conduit hot dip galvanized inside and outside installed:
    - .1 On the exterior of building;
    - .2 Where exposed to mechanical damage;
    - .3 Where conduits turn up or turn down out of concrete slab;
    - .4 Damp and wet locations.
  - .2 Steel galvanized electrical metallic tubing (EMT) installed:
    - .1 In partitions;
    - .2 In ceiling spaces;
    - .3 In service spaces.
    - .4 In masonry walls.



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BASIC MATERIALS AND METHODS

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- .3 Rigid PVC (unplasticized) conduit except for exit light, emergency lighting, and fire alarm system installed:
  - .1 In slabs with rigid steel galvanized turn-up;
  - .2 Underground with rigid steel galvanized turn-up;
  - .3 In concrete walls;
- .4 Flexible armoured conduit:
  - .1 In partitions;
  - .2 For lighting fixture drops;
  - .3 From ceiling junction boxes into wall outlets;
  - .4 Flexible armoured conduits shall be limited to 10'-0" lengths where run horizontally from take-off junction boxes.
- .5 Liquid tight flexible conduit
  - .1 Final connection to motors.
  - .2 Any equipment which vibrates or generates noise.
- .6 For EMT use steel concrete tight set screw fittings as manufactured by Thomas & Betts or approved equivalent. Die cast or pressure cast fittings are not acceptable. For rigid steel conduit use only steel or malleable iron threaded fittings. Threadless, die cast or pressure cast fittings are not acceptable.
- .7 ENT may be used where permitted by OESC, when provided with mechanical protection as required by OESC.
- .8 Provide bushings on the ends of all conduits in enclosure, boxes, panels and cabinets, to protect the conductor installation. Except where grounding bushings are specified, use all plastic insulated bushings temperature rating 150°C with double locknuts.
- .9 Use PVC conduit for all landscaping locations where conduit comes in contact with soil. Refer to Landscape Drawings for final elevation of planting soil. Co-ordinate and adjust electrical devices accordingly.
- .10 Conceal all conduits except in service spaces, mechanical rooms, electrical rooms and areas with ceilings.
- .11 Install all locknuts and bushings to ensure a secure mechanical and electrical bond. Use Erickson (by Thomas & Betts) couplings in lieu of running threads.
- .12 Where conduit joints occur in concrete, use silicone sealing compound to make watertight.
- .13 Lay out conduit to drain free of all moisture.
- .14 Securely hold conduits in place in concrete or masonry during pouring and construction operations; provide templates, forms and spacers as necessary.

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BASIC MATERIALS AND METHODS

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- .15 Support multiple runs of conduit on channel or angle iron with rod hangers.
- .16 Secure all conduits in place with conduit clamps Thomas & Betts or approved equivalent. Perforated pipe straps, wire lashings, wood screws or nails are not acceptable.
- .17 Provide conduit expansion joints where conduits cross building expansion joints, also in straight runs of conduit 30 m (100') or longer. Conduit expansion joints shall be telescoping sleeve type, with insulated bushings and ground jumper.
- .18 Make field bends and offsets uniform and symmetrical without flattening conduit. Minimum bending radius shall be 10 times the conduit diameter.
- .19 Ream conduit ends to remove burrs and sharp edges. Fit conduit stubs with waterproof plastic caps during installation to protect threads and to prevent entrance of moisture into conduit.
- .20 Test all conduits for clear bore using ball mandrel, brushes and snake. Clear any conduit which rejects the ball mandrel. Replace if necessary. Bear all costs involved in making all work good, restoring all surfaces to original condition.
- .21 Install a continuous nylon cord 180 kg (400 lb) test in each conduit left empty.
- .22 Install a copper ground conductor within the flexible conduit at each connection.
- .23 Provide conduit seals in conduits which pass to the outside.
- .24 Provide pull boxes, fittings or junction boxes in conduit runs, on the basis of not more than two right angle bends or their equivalent or not more than 30 m (100'), in straight runs between boxes. For outdoor direct buried conduit, up to 50m.
- .25 Size conduits to code requirements, provide larger sizes where noted.
- .26 Size conduits for low voltage wiring in accordance with the manufacturer's recommendations.
- .27 Provide conduit sealing fittings and correspond for hazardous application to Electrical Safety Code requirements.
- .28 Maximum conduit size permitted in a concrete slab shall be 35 mm. In any case verify with the Structural Consultant for acceptability.
- .29 Where multi-conduits parallel run and/or crossover in concrete slab/wall, verify with Structural Consultant for acceptability.

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BASIC MATERIALS AND METHODS

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- .4 Surface metal raceway
  - .1 Provide surface raceway as required. The surface metal raceway systems shall consist of surface metal raceway, appropriate fittings and device brackets to complete installation.
  - .2 The raceway is to be utilized in dry interior locations only as per Ontario Electrical Safety Code.
  - .3 Submit drawings for approval showing the complete layout of all products that make up the complete system for each floor prior to installation with raceway lengths, device type (power and data), locations and circuits identified, complete with data sheets and samples.
  - .4 The surface raceway system specified herein for branch circuit wiring and/or data network, voice, video and other low-voltage wiring shall be Hubbell HBL4750 series or Wiremold V4000 Series. The raceway shall be metal, two-piece design with a base and a snap-on cover. The raceway shall be complete with one integral barrier in the base for power/data separation. Power shall be in top; data in the bottom. Finish shall be ivory unless otherwise noted.
  - .5 For individual devices located on surfaces where conduit cannot be recessed, provide single or double channel raceway system products.
  - .6 Receptacle / Data plates shall be Wiremold V4047 series, or approved equivalent by Hubbell.
  - .7 Exposed raceway in finish area (not in service spaces, mechanical/Electrical room, ceiling, etc) shall be: Hubbell Incorporation HBL500 series or Wiremold (by Legrand Canada) V700, ivory finish.
- .5 Install raceways system complete with appropriate fittings such as connectors, bushings, elbows, couplings, locknuts, expansion fittings, fasteners and supports and accessories supplied as integral parts of assembly, as specified. Installation shall comply with Ontario Building Code and Electrical Safety Authority requirements.
- .6 Neatly install exposed raceway running parallel to and at right angles to building lines and equally spaced in groups.
- .7 Keep raceway ends parallel and on proper spacing to suit knockouts or raceway openings in equipment or enclosure.
- .8 Keep raceways at least 150 mm clear of heating pipes, flues and hot item surfaces. Where required clearance cannot be provided, obtain written approval from the Consultant to alter layout or to reduce clearance.
- .9 Provide expansion couplings, with bonding jumper and ground clamps where raceways cross building control joints.

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**BASIC MATERIALS AND METHODS**

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- .10 Use only metallic, enclosed raceway on installation that required shielding of electrical cables or where installed in ceiling used as return air plenum, as specified or indicated on the Drawings.
- .11 Raceways shall have established positive low resistance paths to ground and effectively isolate conductors so that any short-circuit arc is confined.
- .12 Select appropriate fittings, such as grounding bushings, bonding and grounding straps, to maintain continuity and effectiveness of grounding of raceway system.
- .13 Provide necessary fasteners and supports acceptable for type and size of raceways, to ensure rigid, complete assembly.
- .14 Provide suitable inserts or expansion type machine bolts for fastening raceways, fittings, boxes and equipment to concrete surfaces.
- .15 Do not use wood screws, lag screws, expansion shields, rawl plugs and nylon inserts.
- .16 Secure raceway and other associate work to structure members. Raceway shall not be supported from ceiling suspension system.
- .17 Thoroughly clean raceway and dry clear obstructions before pulling cable or wire.
- .18 Minimum raceway size: 16mm (1/2") conduit equivalent system.

**2.4 OUTLET AND CONDUIT BOXES**

- .1 Comply with the requirements of latest edition of the followings:
  - .1 CSA Standard C22.2 No.18, Outlet Boxes, Conduit Boxes and Fittings.
  - .2 CSA Standard C22.2 No. 85, Rigid PVC Boxes and Fittings.
- .2 Outlet and conduit boxes - general
  - .1 Size boxes in accordance with CSA C22.1.
  - .2 102mm square or larger outlet boxes as required for special devices.
  - .3 Gang boxes where wiring devices are grouped.
  - .4 Blank cover plates for boxes without wiring devices.
  - .5 347V outlet boxes for 347V switching devices.
  - .6 Combination ganged boxes with appropriate steel removable barriers where outlets for more than one system are grouped.
  - .7 Where standard make boxes are not suitable, provide boxes of special design to fit space and other requirements.
  - .8 Where vapour proof lighting is specified, provide matching vapour proof ceiling or wall junction boxes and fittings as required.
- .3 Sheet steel outlet boxes
  - .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 mm x 50 mm x 38mm or as indicated. 102mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

#### BASIC MATERIALS AND METHODS

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- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 mm x 54 mm x 48mm.
- .3 102mm square or octagonal outlet boxes complete with steel fixture studs where supporting lighting fixtures. Die cast fittings not permitted.
- .4 102mm square outlet boxes with extension and plaster rings for lush mounting devices in finished plaster or tile walls.
- .4 Masonry boxes
  - .1 Electro-galvanized stamped steel masonry single and multi gang boxes for devices flush mounted in exposed block walls, minimum size 95 mm x 50 mm x 64mm standard and 102 mm x 57 mm x 61mm for 347V.
- .5 Concrete boxes
  - .1 Electro-galvanized stamped steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.
- .6 Floor boxes
  - .1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear receptacles. Minimum depth: 28mm for receptacles; 73mm for communication equipment.
  - .2 Round (Floor Mount): 84mm x 63mm deep minimum complete with side and bottom knock-outs.
  - .3 Rectangular: one, two, or three gang flush device floor boxes minimum size 110 mm x 81 mm x 70mm removable barriers for power/low voltage cables, complete with side and bottom knockouts.
  - .4 Multi-Outlet: Electro-galvanized stamped steel concrete type, combination power / communication, flush mounting complete with modular device plates, side and bottom knockouts, lift-up cast aluminum recessed cover and cable lid, black epoxy powder finished 229 mm x 257 mm x 76mm deep, or 64 mm deep.
  - .5 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 16mm and 21mm conduit.
  - .6 Raised Access Floor Boxes
    - .1 Electro-galvanized steel, combination power and communication. Flush in raised floor tile complete with lift-up cast aluminum recessed cover and cable lid. Modular device plates, 254mm flexible armoured cable and plug for power
    - .2 Dimensions: 203 mm x 152 mm x 114mm.
- .7 Conduit Boxes
  - .1 Cast FS or FD aluminum, or ferrous alloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.
  - .2 PVC FS or FD boxes or PVC conduit where required in special corrosive areas as indicated on the Drawings.

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BASIC MATERIALS AND METHODS

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- .8 Fittings - General
  - .1 Bushing and connectors with nylon insulated throats.
  - .2 Knock-out fillers to prevent entry of debris.
  - .3 Conduit outlet bodies for conduit up to 35mm and pull boxes for larger conduits.
  - .4 Double locknuts and insulated bushings on sheet metal boxes.
- .9 Installation
  - .1 Support boxes independently of connecting conduits.
  - .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of the work of this Section.
  - .3 For flush installations, mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
  - .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washer are not allowed.
  - .5 Size and install appropriate boxes and enclosures in accordance with applicable section(s) of Ontario Hydro Electrical Safety Code and the manufacturer's recommended procedures.
  - .6 Coordinate location and installation of boxes so as to be accessible and clear from building system equipment, etc.
  - .7 Install pull boxes in inconspicuous but accessible locations.
  - .8 Use pull boxes for conduits larger than 35mm. Use conduit outlet bodies for conduit 35mm.
  - .9 Provide approved hole plugs in unused conduit knockouts and openings.
  - .10 Furnish boxes and enclosures with corrosion resistant machine screws.
  - .11 Boxes and enclosures embedded in concrete for flush mounting, shall be secured properly with connecting conduits and related works set in place before concrete is poured. Forms, when used, shall be able to be removed without disturbing installed boxes or enclosures.
  - .12 Ensure junction and outlet boxes mounted in ceiling cavities do not interfere with removal of ceiling tiles.
  - .13 Use masonry boxes for flush mounting in exposed block walls, concrete boxes for flush mounting in concrete wall.
  - .14 Furnish conduit boxes with neoprene gaskets for outdoor area or hazardous area application.
  - .15 Install all wall boxes for door security access devices, fire alarm devices, etc., adjacent to lock side of door openings unless otherwise shown. Check door swing before installing any switch.
  - .16 Install all boxes in walls so that tapped holes for mounting wiring devices or fixtures will be aligned vertically or horizontally, as required. Where boxes are grouped at one location with common and varying mounting heights, align boxes horizontally and vertically from centre line unless otherwise indicated.

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## BASIC MATERIALS AND METHODS

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- .17 Offset outlet boxes in sound attenuating partitions to avoid undue transmission of sound between the partition elements. Use flexible conduit connections where wiring is required between outlet boxes on opposite sides of partition.
- .18 Offset outlet boxes where installed on either side of a fire separation.
- .19 Where steel supports are required for outlet boxes, wood supports are not acceptable.
- .20 Maintain integrity of vapour barriers along building perimeter wall where flush outlet boxes are required.

### 2.5 CONTACTORS

- .1 Conform to the requirements of latest edition of CSA C22.2, No. 14 – Industrial Control Equipment.
- .2 Provide enclosed lighting contactors motor loads. The contactors shall be fully rated and withstand the large initial in-rush currents the motor lamps without contact welding.
- .3 Contactors shall be NEMA rated, magnetic, electrically operated, mechanically held, complete with suitable type enclosure and 24 coil..
- .4 Fail open: contacts shall open upon the supply voltage drop below 75% of the rated voltage.
- .5 Accessories
  - .1 Pilot lights (ON/OFF).
  - .2 Auxiliary contacts (NO and NC) and relays to match control function.
  - .3 Control circuit fuse-holders and fuses.
- .6 Manufacturers:
  - .1 Cutler-Hammer – Eaton Corporation
  - .2 Schneider Electric
  - .3 Siemens Canada

### 2.6 ACCESS PANELS AND DOORS

- .1 All access panels and doors shall be Milcor or Bel, 12 gauge with concealed hinges.
- .2 In glazed tile walls provide #304 alloy stainless steel with #4 finish recessed frame and secured with stainless steel countersunk flush head screws.
- .3 In plaster surfaces, provide dished steel door for plaster finish with welded metal lath and plastic grommet for keyhole.
- .4 In other finishes, use plain steel door with lock and anchor straps, complete with factory prime coat.
- .5 In lay-in ceilings, tiles properly marked may serve as access panels.

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## BASIC MATERIALS AND METHODS

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- .6 Provide the appropriate Division of Work with panels and doors, complete with frames and all pertinent information for installation. Arrange for that Division of Work to install the relevant panels and doors. Ensure that all panels and doors are flush mounted and properly aligned with building modules and grids. Indicate locations on record drawings.
- .7 Select all access panels and doors to provide adequate access, and to suit appropriate architectural finish, minimum size 150 mm x 150 mm (6" x 6"). Where necessary for persons to enter, provide minimum 600 mm x 450 mm (24" x 18") size doors.

### 2.7 SPRINKLER PROOF EQUIPMENT

- .1 Provide all equipment in sprinklered areas with accessories to prevent the entry of water into the enclosures in the event that the sprinkler system is activated.
- .2 Materials
  - .1 CSA enclosure type 2.
  - .2 Louvres facing outward and downward where openings are required for heat dissipation. Expanded metal screening is not acceptable.
  - .3 CSA certified sealing rings for rigid steel galvanized conduit and CSA certified raintight connectors for steel galvanized electrical metallic tubing (EMT) or other raceways as required.
- .3 Provide seal rings and raintight connectors on all conduit terminations entering the top or side of all enclosures and for all conduit terminations for pull boxes, junction boxes, splitter troughs, wireways, auxiliary gutters, cable troughs and disconnect switches installed below the level of the sprinkler heads.
- .4 Refer to the Mechanical Drawings for extent of sprinklered areas.

### 2.8 BACKBOARDS

- .1 Provide backboards for all surface mounted power distribution equipment. Provide backboards for telecommunication systems as indicated on the Drawings.
- .2 Backboards shall be minimum 0.76" (19mm) thick, good one (1) side fire retardant plywood backboards, pressure impregnated with fire retardant chemicals, and stamp. Conform to the requirements of CSA 080.
- .3 Construct each backboard in a rectangular shape of the size as indicated. Where no size is indicated, provide a backboard a minimum 4" (100mm) higher than the equipment. Where more than one piece of equipment is installed on the backboard, construct the backboard of a size to suit the maximum vertical and horizontal dimensions of the equipment. Backboards for Telecommunication system shall be minimum 4" (W) x 8" (H).
- .4 Finish each backboard with one coat of primer followed by a minimum of one finish fire retardant coat of ASA 61 grey paint prior to installing any equipment.



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**BASIC MATERIALS AND METHODS**

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- .5 Fastenings:
  - .1 Fasten each backboard to a wall or to a support structure using cadmium plated hardware. Provide a flat washer under the head of each fastener. Recess the head of the mounting bolt where equipment, including future equipment, is to be installed.
  - .2 Use expansion shields, toggle bolts or other types of wall fastenings to suit the wall type. Align the mounting bolts with the wall studs for stud type walls.
  - .3 Install fastenings a maximum 20" (500mm) apart in both the vertical and horizontal directions.
  - .4 When installing equipment heavier than 50kg, fasten the equipment through the backboard directly to the wall or support structure.

**2.9 METALS**

- .1 Metal construction required for the electrical work shown on the structural drawings will be carried out by Division 05.
- .2 Provide all other electrical work such as, but not limited to, equipment bases, supports, catwalks, framework to support checker plates and electrical equipment above trenches and cable pits, ladders, etc. pit and trench covers, and as called for on the electrical drawings. Have such work carried out in accordance with the requirements of Division 05.

**2.10 SLEEVES AND CURBS**

- .1 Provide conduit sleeves of galvanized steel for conduit and cable runs passing through concrete walls, beams, slabs and floor. Cut flush with finished surface.
- .2 Extend galvanized conduit sleeves for conduit rising through slabs 4" minimum above finished floors.
- .3 Through exterior walls below grade waterproofed floors, and other waterproof walls use heavy weight cast iron pipes machine cut. Extend sleeves 100 mm (4") above finished floors, and cut flush with underside of floor.
- .4 For rectangular duct openings for bus ducts and cable tray use minimum 18 gauge galvanized steel sleeves or provide a removable wood box-out of the required size. Brace sleeves to retain their position and shape during the pouring of concrete and other work.
- .5 Seal sleeves and openings to maintain fire rating. Use Dow-Corning Corporation #3-6548 'Silicone RTV' foam, Thomas & Betts 'Flamesafe' firestop system, installed in accordance with the manufacturer's specifications and recommendations.
- .6 Seal all openings and sleeves after installation of equipment:
  - .1 With an approved material to maintain fire rating where sleeves and openings pass through fire separations and floors.

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**BASIC MATERIALS AND METHODS**

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- .2 With an approved material to maintain fire rating for sleeves and openings provided for future equipment.
- .7 Size sleeves to provide 13 mm (1/2") clearance all around.
- .8 Provide all flashing and waterproofing for sleeves through roof and exterior walls to the requirements of Division 7, Thermal and Moisture Protection.
- .9 Except where furred in provide watertight concrete curbs, 100 mm (4") high by 100 mm (4") wide with 19 mm (3/4") chamfered edges around all sleeves and openings passing through waterproof floors.

**2.11 SUPPORTS AND BASES**

- .1 Submit proposed method of attachment of hangers and beam clamps, to cellular steel deck to the Consultant for approval before proceeding with the work.
- .2 Supply and erect special structural work required for the installation of electrical equipment. Provide anchor bolts and other fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.
- .3 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets.
- .4 Provide channel or other metal supports where necessary, to adequately support lighting fixtures. Do not use wood unless wood forms part of the building structure.
- .5 Secure supports, in general to structure, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members, required between beams for supporting conduits and cables.
- .6 Provide any additional supports required from existing concrete construction for any piping or equipment, by drilling same and installing expansion bolt cinch anchors.
- .7 Do not use explosive drive pins in any section of the Work without obtaining prior approval from the Consultant.
- .8 Hangers for electrical conduit shall be galvanized after fabrication. Conduit hangers shall be as manufactured by:
  - Burndy Canada Ltd.
  - Canadian Strut Products Ltd.
  - E. Myatt & Co. Ltd.
  - Steel City Electric Co.
  - Thomas & Betts
  - B-line (by Eaton Corporation)

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**BASIC MATERIALS AND METHODS**

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- .9 Do not use, perforated strapping (grappler bars).
- .10 Steel supports in wet or dry locations to be galvanized after fabrication.
- .11 Provide concrete housekeeping pads or bases for all floor mounted equipment 100 mm (4") high with 19 mm (3/4") chamfered edges, keyed to the floor slab and extending at least 100 mm (4") on all sides of the equipment. Where draw-out truck type circuit breakers are provided extend pad to accommodate complete withdrawal of breaker. Provide and set all anchor bolts.
- .12 Use only factory made threaded or toggle type insert.
- .13 Place inserts only in structural members and not in the finishing material.
- .14 Provide bus ducts, cable trays, and wireways with fire barriers at each floor level and fire separation.
- .15 Provide locations and dimensions for all pads and curbs and provide and set all anchor bolts for all concrete work provided under Division 3 - Concrete.

**2.12 SPARE PARTS**

- .1 Furnish spare parts and maintenance materials as recommended by the equipment manufacturer and as appropriate for a period of two years after acceptance of the Work.
- .2 Dome Lights
  - .1 Rounded dome shape, clear lexan lens, white plate 5" square, 15/75 cd strobe rating.
  - .2 Rating: 0.03A at 120VAC.
  - .3 Wall mounted in recessed box 100mm above the door or at 2300mm AFF.
  - .4 Tork#TA5508H-N5 or equal.

**2.13 CORD REEL RECEPTACLES**

- .1 Ceiling mounted, complete with mounting auxiliaries.
- .2 15A, 120V, 13.7 meter, 12/3 SJEO cable.
- .3 Weather proof GFI 15A receptacles.
- .4 Hubbell Incorporation #HBL45123 series. Alternate: Appleton Electrical Products.

**PART 3 - EXECUTION**

**3.1 NEUTRALS AND PHASING**

- .1 Provide one identified grounded neutral conductor for each set of branch circuits connected to different mains of each panel.
- .2 For circuits identified as computer dedicated (D) or isolated ground (IG), provide individual neutral per identified circuit.

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## BASIC MATERIALS AND METHODS

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- .3 Install a separate neutral for each GFCI circuit when the GFCI is located at the panelboard.
- .4 Connect two or three circuits sharing a common neutral to different mains or phases.
- .5 Balance the connected loads across the mains of each panel to within 15%.
- .6 Circuit numbers on the panels must correspond to the numbers on the Drawings.
- .7 Connections in all equipment to be Phase A, B and C from left to right, and front to back when viewing from the front or accessible direction.

### 3.2 MOUNTING HEIGHTS

- .1 Mounting heights are from floor level to centre line of device outlet, unless noted otherwise. Confirm all locations with the Consultant before installation. In all areas accessible to persons in wheelchairs, the mounting heights of all switches, thermostats, intercom switches, pull stations, etc., required by the OBC "Barrier Free" shall comply with OBC requirements.
- .2 The mounting heights of all power and lighting devices shall comply with Ontario Electrical Safety Code requirements. The mounting heights of all fire alarm devices shall comply with CSA requirements.
- .3 If mounting height of equipment is not specified or indicated on the Drawings, verify with the Consultant before proceeding with installation.
- .4 Install electrical equipment at following heights (centre of device) unless indicated otherwise.
  - .1 Wall switches, dimmers, timers, speed controllers, speaker volume controllers, thermostats and hand dryers: 1200 mm.
  - .2 Wall receptacles:
    - General: 600 mm in Vehicle Bay and 450 mm in other areas
    - Above top of continuous baseboard heater: 250 mm minimum.
    - Above top of counters or counter splash backs: 250 mm.
    - In mechanical rooms: 1200 mm. (gang with switch)
  - .3 Panelboards: as required by O.B.C. and O.E.S.C. or as indicated.
  - .4 Telephone, TV and data outlets: 600 mm in Apparatus Bay and 450mm in other areas.
  - .5 Wall mounted speakers: 150mm below ceiling or 2300 mm.
  - .6 Security key switches, card readers and intercom switches: 1200mm.
  - .7 Security wall-mounted motion sensor: 150mm below ceiling or 2300mm.
- .5 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, these Documents and requirements of Local Authority Having Jurisdiction.

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**BASIC MATERIALS AND METHODS**

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**3.3 WIRING OF MECHANICAL EQUIPMENT**

- .1 Coordinate all the work with the work of Mechanical Divisions 21, 23 and 25 to ensure proper location of equipment. The locations of starters, motors and associated equipment indicated on the drawings are approximate and diagrammatic only. 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 the equipment manufacturers.
- .2 Provide all electric baseboard heaters, cabinet heaters, force flow unit heaters and heating cables. Electric duct heaters are to be provided under the work of the Mechanical Division.
- .3 Provide safety disconnect switches required at motors by OESC whether shown on the Drawings or not. Provide power wires and connections to all mechanical equipment.
- .4 All the motor starters/controllers, and/or line voltage thermostats shall be supplied under the Mechanical Division and installed by the Electrical Division. The work of the Electrical Division shall provide safety disconnect switches and power connections to the motors. The work of the Mechanical Division shall provide all the control wiring, control devices and low voltage thermostats.
- .5 Where motor starters, switches and the like, are grouped together, provide suitable plywood backboard to which all such equipment shall be secured.
- .6 Where the single-phase exhaust fan shall be controlled by manual switch, the work of the Electrical Division shall provide power connections to the fan, heavy-duty toggle control switch and provide the safety disconnect means.
- .7 Wiring and connections from fire alarm system to motor starters/control panels for motor control operations. Co-ordinate with the work of the Mechanical Division.
- .8 Where applicable, power supplies to MCC. The work of the Mechanical Division shall provide MCC, main lugs, power supplies and controls to motors.
- .9 Fire alarm signals to starters / control panels and MCC.

**3.4 SERVICES TO EQUIPMENT SUPPLIED BY OWNER / OTHER DIVISIONS**

- .1 Provide all necessary connections required for equipment supplied by the Owner and other Divisions. Examine all Drawings and Specifications and identify all requirements.
- .2 Verify the type, rating and location of all outlets and/or connections required for all equipment provided by the Owner and other Divisions.
- .3 Provide isolation devices as required to the equipment for all services.

**3.5 PROVISION FOR FUTURE EQUIPMENT AND CONSTRUCTION**

- .1 Spaces designated for future equipment or building expansion shall be left clear.

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**BASIC MATERIALS AND METHODS**

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- .2 Provide services for future extensions complete with Products necessary for present termination and to permit future extension.
- .3 Identify each service by a permanent marker at its termination point.

**3.6 CUTTING AND PATCHING**

- .1 Provide all cutting and patching required for the work of the Electrical Division. Work shall be carried out in conformance with the requirements of Division 02. Include any radiography required to locate concealed services before penetrating into inaccessible locations.
- .2 Any modifications to building shall be done so as not to diminish structural, fire resistance, or smoke barrier integrity.
- .3 Proposed modifications to structure shall require acceptance by the Structural Engineer.
- .4 The Contractor shall provide the Consultant with the opportunity to review the intent prior to any major cutting.

**3.7 PAINTING**

- .1 Provide all exposed ferrous metal work, and Products, except conduit, with at least one factory prime coat or paint one prime coat on Site. Clean up or wire brush all equipment before painting. Unless otherwise noted in the Contract Documents, finish painting will be done under Division 09 - Finishes of these Specifications.
- .2 If not factory coated, clean, wire brush and paint all ferrous supports and hangers concealed in ceiling spaces of kitchens or other similar high humidity areas. Do not paint galvanized supports and hangers.
- .3 Repaint or refinish all damaged factory applied finishes.
- .4 Provide oil base red oxide primer applied as per the manufacturer's recommendations.

**3.8 VIBRATION AND NOISE CONTROL**

- .1 Spring type vibration isolations shall be complete with horizontal spring constant (kH) to vertical (kV) ratio between one and two to assure stability. Select springs to operate no greater than 2/3 solid deflection. For indoor mounting use springs with one coat of zinc chromate primer and two coats of paint. For outdoor mounting use springs of neoprene coated steel or stainless steel. All spring housings are to be hot dipped galvanized. Where the spring assembly is bolted to the floor, provide vibration isolation washers and pads to reduce transmission of vibration.
- .2 Pad type isolators shall be rubber for indoor application, neoprene for oil filled devices and for outdoor use. Use 30 durometer rubber and 50 durometer neoprene. Select pad type isolators which do not exceed the mid-point of their recommended operating rate with maximum deflection of 20% of thickness. Use minimum 6 mm (1/4") thick pads under spring assemblies.

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#### BASIC MATERIALS AND METHODS

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- .3 Provide spring type vibration isolators for IC engine driven equipment. Raise equipment to operating height, leveled with blocks and shims so that connections can be made to a rigid system at operating level before isolator adjustments.
- .4 For power class transformers provide spring or pad type isolators in accordance with the manufacturer's recommendations. Where dry type transformers are contained within unit substation enclosures mount the core and coils to the structural framing of the unit substation. Locate isolators between core and coil frame and unit substation structural frame.
- .5 Provide pad type isolators for all floor mounted dry type distribution transformers. Locate isolators between transformer enclosure and floor.
- .6 Where transformers are platform mounted from the structure above, provide spring hangers with leveling devices and sound pads in all supports.
- .7 Make connections to rotating, vibrating, magnetic or other noise producing equipment such as motors, transformers, and between independent structure by means of loop flexible conduits.
- .8 If objectionable noise or vibration should be transmitted to occupied portions of the building by any part of the electrical work, make necessary changes and/or additions, to the Consultant's approval, without addition to the Contract Price.

### 3.9 CONCRETE

- .1 Concrete work shown on the structural drawings will be performed as part of Division 03 - Concrete.
- .2 Provide all other concrete work necessary for the work of this Division and have such work carried out in accordance with Division 03 - Concrete.

### 3.10 EXCAVATION AND BACKFILLING

- .1 Before commencement of the excavation of the Work, determine with the Consultant, the Local Municipalities and utilities, the presence of existing underground services at the Site and verify satisfactory condition. Locate such services and mark out the same. Ensure that all Subcontractors concerned are aware of their presence.
- .2 Perform all excavation and backfilling up to grade required for the electrical work inside and outside of building. Check available soil test reports. Obtain instructions from the Consultant regarding the type of soils and their extent.
- .3 Carry out all trench excavation in strict conformity with all applicable acts and bylaws.
- .4 Excavate to the required depth and width. Backfill excess excavation.
- .5 For direct buried cable in all soil 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 granular 'A' gravel or sand.

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BASIC MATERIALS AND METHODS

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- .6 Provide ducts under roads and paved areas.
- .7 Refer to details and to Hydro One requirements for concrete encased duct installations.
- .8 Where excavation is necessary in proximity to and below the level of any footing, provide a sleeve at the proximity and backfill with 14,000 kPa (2,000 psi) concrete to the level of the highest adjacent footing. Proximity is determined by the angle of repose as established by the Consultant.
- .9 Protect the bottom of excavations against flooding and freezing. Use pumping or other means to keep the bottom dry. Do not open more than weather will permit. Have excavations inspected at least once a week ESA Inspector and Hydro One. Break up rocks and boulders and remove these by drilling and wedging. Do not use blasting unless approved in writing by the Consultant.
- .10 Compact all backfill to a density of 95% Modified Proctor. Before backfilling, obtain approval. Remove all shoring during backfilling. Obtain approval for all compaction machines used.
- .11 Backfill trenches within building, with clean sharp sand in individual layers of maximum 150 mm (6") thickness. Manually compact the first layers up to a compacted level of 300 mm (12"). Machine compact the balance up to grade, using approved equipment.
- .12 Backfill trenches outside buildings, not under roads, parking lots, or traffic areas, manually compact up to a compacted level of 450 mm (18") above the cable or duct bank with individual layers of material up to 150 mm (6") thick, using sand or granular 'A' gravel. Machine compact the balance up to grade with 150 mm (6") layers of approved excavated material.
- .13 Backfill all other trenches outside buildings with granular 'A' gravel in layers not exceeding 150 mm (6") thickness, up to grade level; manually compact up to 450 mm (18"), machine compact the balance.
- .14 Do not use water for consolidation or during compaction of backfill, unless approved in writing by the Consultant.
- .15 After a period has passed adequate to reveal any settlement, fill all depressions to correct grade level with appropriate material, machine compacted. Pay all costs required to make good all damage caused by settlement.
- .16 Store and dispose of excavated materials as follows:
  - .1 During the progress of the Contract, place the material as directed in such a manner that a minimum of damage or disfigurement of the existing ground will result and the material will not in any way impede the progress of the work. Dispose of surplus material as directed by the Consultant.
  - .2 Place surplus topsoil separately from subsoil. Leave the Site clear and unencumbered.



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**BASIC MATERIALS AND METHODS**

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- .3 Protect, brace, support as required existing pipes, ducts, cables, etc. encountered in the Work. Do not disturb or interrupt the operation of any services without written approval from the Consultant.

**3.11 CONCRETE ENCASED DUCT BANKS**

- .1 Provide PVC duct runs consisting of parallel ducts encased in concrete as indicated on drawings.
- .2 Ducts and concrete encasement for Power Supply Authority service cables shall comply with their standards and requirements.
- .3 Place and set all ducts and accessories and supervise to ensure integrity of complete installation.
- .4 Comply with the requirements of the latest editions of CSA 22.2 No. 211.1, Rigid Types EB1 and DB2/ES2 PVC Conduit.
- .5 Join ducts together with an approved coupling to provide a sound and watertight joint. Stagger joints in adjacent ducts by not less than 200 mm (8"). Where PVC and bell fittings are used make connections to duct with an approved PVC solvent.
- .6 Install ducts with spacing of not less than 190 mm centre to centre both horizontally and vertically. Use only plastic or masonry spacers. Provide two spacers minimum per 3000 mm (120") length of duct.
- .7 Grade ducts not less than 75 mm (3") per 30 m (100') for drainage and provide drainage facilities as detailed.
- .8 Encase ducts with 3000 pound concrete with a minimum cover of 75 mm (3") on all sides using pea gravel aggregate. Work concrete below and between ducts to product a homogeneous mass. Provide reinforcing steel. Anchor all ducts in place in such a manner as to ensure that there is no movement during the placing of concrete.
- .9 Immediately after concrete has been placed, test each duct with a mandrel that is a minimum of 300 mm (12") long and having a diameter 7 mm (1/4") less than the diameter of the duct. After all obstructions have been cleared pull a stiff bristle brush through each duct to remove all sand and other foreign material. Install a 225 kilogram (500 lb) test rope or other equivalent non-metallic cord in each duct and seal all ends with standard plastic duct plugs.
- .10 Provide end bell fittings at duct bank finished end face.

**END OF SECTION**

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GROUNDING

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
-------------------	--------------

PART 1 - GENERAL

1.1	Summary
-----	---------

PART 2 - PRODUCTS

2.1	Materials
-----	-----------

PART 3 - EXECUTION

3.1	Installation
-----	--------------

## GROUNDING

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### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- .1 Comply with General Conditions, Supplementary Conditions, and Section 26 01 00 – Electrical General Requirements.
- .2 Provide all grounding to comply with the Ontario Electrical Safety Code (OESC) and the latest instructions of the Electrical Safety Authority with any further requirements as noted herein.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- .1 All grounding conductors stranded copper, bare or insulated as required.
- .2 All grounding conductors stranded copper, bare or insulated as required.
- .3 Use Cadweld process for all weld connections. Burndy Canada Inc. and/or AMP of Canada Ltd. mechanical grounding connectors are an acceptable equivalent to welded connections.
- .4 All ground connectors to be designed and approved for grounding purposes.
- .5 Ground buses: 7 mm x 40 mm, 305 mm long or as required.
- .6 Ground electrodes: 3040 mm x 20 mm copper clad steel ground rods.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- .1 Provide ground busses in the main electrical room for use in bonding equipment in the room. Ground the buses in accordance with the OESC. Provide ground connections from buses to main low voltage switchboards and all exposed metal work. Provide ground connections to the main water supply pipe.
- .2 Connect the ground bus inside the switchgear assembly to the grounding system.
- .3 Inside main secondary switchboard, connect the neutral bus to the ground bus with conductor rated minimum 25% main bus rating.
- .4 Connect each transformer neutral to main ground bus in main electrical room with separate protected ground conductor to electrical safety code requirements.
- .5 Connect the ground bus in each emergency distribution panel to the grounding system. Connect generator to the grounding system.
- .6 Bond all interior non-electrical metallic piping systems to the electrical system ground including, but not limited to, water supply, wastewater, and gas systems.
- .7 Bond all conduit, and all non-current carrying metal parts, equipment cases, frames, bases, brackets, etc.

## GROUNDING

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- .8 Bond each piece of fixed equipment back to the switchboard or panel feeding that equipment, by one of the following methods:
  - .1 Where equipment is fed by a steel conduit, provided sizing is adequate, utilize conduit for the ground return conductor. At switchboard, provide a grounding bushing, and strap such conduits to the ground bus (size in accordance with OESC).
  - .2 Where the size of the conduit is inadequate (in accordance with the OESC), or if the conduit is flexible, install a separate insulated copper ground inside the conduit. At the switchboard or distribution panel, provide a grounding bushing, loop the ground conductor through the bushing, and connect to the switchboard ground bus. At the fixed equipment, connect to an internal ground bus, or connect to the inside of the metal enclosure utilizing approved screws and connectors (remove all paint).
  - .3 For branch circuits, the conduits may be used for grounding, provided seamless steel fittings are used on EMT and threaded fittings are used on rigid conduit. At each receptacle connect a stranded copper ground wire from the outlet box to the grounding terminal on the receptacle. Install a separate grounding conductor in all PVC conduits.
  - .4 Where equipment is fed by a multi-conductor power cable, provide a ground conductor in the cable. At the switchboard or panel, connect to the ground bus. Use a grounding connector on the cable for positive grounding of the metallic sheath. Loop the ground wire to the grounding connector.
- .9 Run a separate ground wire in all flexible conduits. Connect each end to ground bus or lug or connector.
- .10 Where mechanical protection is required for insulated grounding conductors install in rigid conduit. Use rigid PVC conduit in concrete or below grade slab and aluminum conduit in other locations.
- .11 Provide weld connection or mechanical grounding connectors for:
  - .1 All connections between grounding conductors.
  - .2 All connections to building steel.
  - .3 All connections between grounding conductors and cable lugs.
- .12 Where single ground conductor is in one conduit, the conduit must be non-ferrous.
- .13 Arrange grounding to provide the minimum impedance paths for ground fault currents. Provide any additional grounding required for approval by the Electrical Safety Authority.

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GROUNDING

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- .14 All low voltage neutral 'XO' of the transformer shall be bonded to the transformer enclosure/frame with a minimum conductor sized in accordance with the OESC, Table 16.

END OF SECTION

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TELECOMMUNICATION RACEWAY SYSTEM

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
-------------------	--------------

PART 1 – GENERAL

1.1	Summary
1.2	Scope

PART 2 - PRODUCTS

2.1	Materials
-----	-----------

PART 3 - EXECUTION

3.1	Installation
-----	--------------

## TELECOMMUNICATION RACEWAY SYSTEM

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- .1 This Specification Section is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with General Condition, Supplementary Conditions, Section 26 01 00 – Electrical General Requirements
- .3 Comply with Section 26 05 00 – Basic Materials & Method.
- .4 Comply with EIA/TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
- .5 Comply with J-STD-607-A, Commercial Building Grounding and Bonding Requirements for Telecommunications.

#### **1.2 SCOPE**

- .1 Provide empty raceway systems including conduits, cable trays, terminal cabinets, plywood backboards, pull boxes, outlets and cover plates for enclosure of wiring.
- .2 Telecommunication systems include, but not limited to, telephone, data cabling, cable TV, P.A., security and access control, emergency alarm, etc.
- .3 Co-ordinate with system contractors for the work of this Section.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- .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 Conduit size shall be in accordance with the systems contractor's requirements and recommended standards.
- .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

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**TELECOMMUNICATION RACEWAY SYSTEM**

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- .4 Plywood backboards shall be minimum size of 1200 mm x 2400 mm, 19 mm thick, painted with two coats of fire retardant light grey enamel.
- .5 Provide a minimum of two duplex receptacles on separate circuits at each backboard.
- .6 Provide grounding at each backboard.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- .1 Vertically mount outlet boxes, unless noted otherwise on the Drawings, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.
- .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 Conduit bonds shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.
- .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.
- .5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to Total Performance of the Work, for use by systems contractors to facilitate wiring and equipment installation. Include the above noted information on final record drawings at Total Performance of the Work.

END OF SECTION



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ELECTRICAL SYSTEM COMMISSIONING

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
-------------------	--------------

PART 1 – GENERAL

1.1	General
1.2	Responsibilities

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1	Submittals
3.2	Start-Up of Equipment
3.3	Pre-Functional Test Sheets
3.4	Operations and Maintenance Manuals
3.5	Training of Owner Personnel
3.6	Deferred Testing
3.7	Written Work Products

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**ELECTRICAL SYSTEM COMMISSIONING**

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**PART 1 - GENERAL**

**1.1 GENERAL**

- .1 The purpose of this section is to specify Division 26 responsibilities in the commissioning process.
- .2 The systems to be commissioned are listed in Section 01 91 00.1.9.
- .3 Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 26 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

**1.2 RESPONSIBILITIES**

- .1 Electrical Contractors. The commissioning responsibilities applicable to the Electrical Contractor are as follows (all references apply to commissioned equipment only):
  - .1 Documentation of all procedures performed shall be provided and forwarded to the engineer. Written documentation must contain recorded test values of all electrical tests performed per the individual product specification.
  - .2 The start-up service company shall be present during energization of the electrical equipment. Jobsite and equipment access must be provided by the Electrical Contractor.
  - .3 The contractor shall supply a power source, specified by the start-up service company, for on-site test equipment.
  - .4 The contractor is to attend all factory witness testing required within the respective specification sections. The contractor is responsible to cover all their costs and include them in their bid.
  - .5 Perform tests using qualified personnel. Provide necessary instruments and equipment.
  - .6 Include the cost of commissioning in the contract price, if not yet let.
  - .7 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.
  - .8 Attend a commissioning scoping meeting and other necessary meetings scheduled by the CA to facilitate the Cx process.

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### ELECTRICAL SYSTEM COMMISSIONING

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- .9 Contractors shall provide normal cut sheets and shop drawing submittals to the CA of commissioned equipment. Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of pre-functional and functional testing procedures.
  - .1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, full factory testing reports (if any), and full warranty information including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
  - .2 The Commissioning Authority may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
- .10 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CA for review.
- .11 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- .12 Provide assistance to the CA in preparation of the specific functional performance test procedures specified in Section 26. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- .13 Develop a full start-up and checkout plan using manufacturer's start-up procedures and the pre-functional test sheets from the CA. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CA for review.
- .14 During the startup and checkout process, execute and document the electrical-related portions of the pre-functional test sheets provided by the CA for all commissioned equipment.
- .15 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.
- .16 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

### ELECTRICAL SYSTEM COMMISSIONING

- .17 Perform functional performance testing under the direction of the CA for specified equipment in Table 1 of this section (Section 26 08 00). Assist the CA in interpreting the monitoring data, as necessary.
- .18 Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, PM/GC and A/E and retest the equipment.
- .19 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- .20 During construction, maintain as-built red-line drawings for all drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings.
- .21 Provide training of the Owner's operating personnel as specified.
- .22 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- .23 Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.
- .24 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

### **PART 2 - PRODUCTS**

- .1 NOT USED

### **PART 3 - EXECUTION**

#### **3.1 SUBMITTALS**

- .1 Section 26 Contractors shall provide submittal documentation relative to commissioning to the CA as requested by the CA. Refer to Section 01 91 00 Part 3.3 for additional Section 26 requirements.

#### **3.2 START-UP OF EQUIPMENT**

- .1 The Electrical Contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in Section 01 91 00, Part 3.4. Section 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning authority or Owner.

## **ELECTRICAL SYSTEM COMMISSIONING**

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- .2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CA and PM. Beginning system testing before full completion, does not relieve the Contractor from fully completing the system, including all Pre Functional test sheets as soon as possible.
- .3 All equipment shall be started by the Manufacturer's representative.

### **3.3 PRE-FUNCTIONAL TEST SHEETS**

- .1 Pre-functional test sheets contain items for Section 26 Contractors to perform. On each checklist, a column is provided that is to be completed by the contractor assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer's recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.
- .2 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout. Items that do not apply should be noted along with the reasons on the form. If this form is not used for documenting, one of similar rigor and clarity shall be used pending approval from the CA. Contractor's assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off. "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = Architect/Engineer, All = all Contractors, CA = Commissioning Agent, CC = Controls Contractor, EC = Electrical Contractor, PM/GC = General Contractor, MC = Mechanical Contractor, SC = Sheet Metal Contractor, TAB = Test and Balance Contractor.

### **3.4 OPERATIONS AND MAINTENANCE MANUALS**

- .1 Section 26 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 26 and deliver to the GC for inclusion in the O&M manuals
- .2 The CA shall receive a copy of the O&M manuals for review.

### **3.5 TRAINING OF OWNER PERSONNEL**

- .1 The GC shall be responsible for training coordination and scheduling and ultimately to ensure the training is completed. Refer to Section 01 91 00 for additional details.

### ELECTRICAL SYSTEM COMMISSIONING

---

- .2 The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment Refer to Section 01 91 00 for additional details.
- .3 Electrical Contractor: The Electrical Contractor shall have the following training responsibilities:
  - .1 Provide the CA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.8.
  - .2 Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
  - .3 Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  - .4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - .5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
  - .6 The training sessions shall follow the outline in the Table of Contents of the Operation and Maintenance (O&M) manual and illustrate whenever possible the use of the O&M manuals for reference.
  - .7 Training shall include:
    - .1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
    - .2 Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
    - .3 Discuss relevant health and safety issues and concerns.
    - .4 Discuss warranties and guarantees.
    - .5 Cover common troubleshooting problems and solutions.

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### ELECTRICAL SYSTEM COMMISSIONING

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- .6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
- .7 Discuss any peculiarities of equipment installation or operation.
- .8 Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
- .9 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
- .10 The Electrical Contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- .11 Training shall occur after functional testing is complete, unless accepted otherwise by the Project Manager.

#### **3.6 DEFERRED TESTING**

- .1 Refer to Section 01 91 00, Part 3.9 for requirements of deferred testing.

#### **3.7 WRITTEN WORK PRODUCTS**

- .1 Written work products of Section 26 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets.

END OF SECTION

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DIGITAL METERING

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CONTENTS

SUBSECTION

TITLE

PART 1 - GENERAL

1.1	General
1.2	References
1.3	Related Work
1.4	Standards
1.5	Description of Work
1.6	Work and Materials Included by Carma Corp. – The Meter Manager™ System Supplier
1.7	Work and Materials Included by the Electrical Contractor
1.8	Submittals
1.9	Commissioning & Training
1.10	Certification and Approvals
1.11	Submetering System Requirements

PART 2 - PRODUCTS

2.1	Drivers for LED Fixtures
2.2	Electronic Field Panels
2.3	Energy Monitoring Pods (EMP)
2.4	Current Transducers and Step-Down Current Transformers
2.5	Potential Transformers
2.6	System Software
2.7	Output File Format & Storage
2.8	Data Storage and Logging Requirements
2.9	Pulse Data Recorder/Pulse Totalizer (Profilr)
2.10	Field Meters
2.11	Acceptable Manufacturers
2.12	List of Field Meters
2.13	System Architecture

PART 3 - EXECUTION

3.1	Installation
3.2	Calibration
3.3	Warranty



## DIGITAL METERING

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### **PART 1 - GENERAL**

#### **1.1 GENERAL**

- .1 All Division 26 general and specific requirements apply to all electrical bidders, as do the requirements of this subsection, utilities submetering system. Purchase/supply and installation of mechanical meters (water, natural gas, BTUs, fluid, etc.) to be provided by Division 21, 23 and 25 mechanical bidders as a supplement to the electrical install price for the submetering system. The design criteria for the Digital Metering System is based on the CARMA Metering Manager System as manufactured by CARMA CORP. The Contractor shall be responsible for all costs associated for proceeding with an acceptable alternate manufacturer as listed in this specification for a fully operational system.

#### **1.2 REFERENCES**

- .1 Division 260100 - Electrical General Provisions
- .2 Division 210501 - Mechanical General Provisions

#### **1.3 RELATED WORK**

- .1 Division 224201 - Water Check Meter
- .2 Division 231123 - Natural Gas Check Meter
- .3 Division 253001 – BTU Energy Check Meter

#### **1.4 STANDARDS**

- .1 Except as noted by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the Canadian Electrical Manufacturer's
- .2 Approved by Measurement Canada (department of ISED Canada) complete with notice of approval (e.g. AE-####, AV-####, AG-####) as legal for sub-metering.
- .3 Meets Canadian Standards based on UL 61010 and is certified and/or SPE-1000 inspected. Compliant with ISED Canada wired and wireless telecommunications requirements (similar to FCC part 15).

#### **1.5 DESCRIPTION OF WORK**

- .1 Provide complete, working, computer based digital metering system (DMS) to break down and track Electricity, Natural Gas, BTU Energy and Water measurements of the building. The DMS will be used to achieve the LEED Measurement and Verification credit.
- .2 The DMS price will include all costs associated with the co-ordination of system installation, material supply, commissioning, installation verification, and customer training during the entire period of construction and system start-up.
- .3 The total number of electrical meters to be monitored by the DMS shall be as shown on the electrical drawings.

#### DIGITAL METERING

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- .4 The total number of mechanical metering points to be monitored by the DMS shall be as shown on the mechanical and electrical drawings.
- .5 The electrical contractor will provide all labour, equipment, materials and services and install all interconnecting wire and conduit required for the Supplier's and/or Owner's digital metering system(DMS) including the conduits and wiring to the electric, water, natural gas and BTU energy meters.
- .6 Provide current transformers (CTs) and potential transformers (PTs) as required by meters.
- .7 The DMS supplier is responsible for integration of water, BTU energy and gas meters, specification confirmed by Mechanical Consultant and supplied by mechanical contractor.
- .8 The DMS Supplier will provide a detailed installation manual to the electrical subcontractor, which recognizes all applicable codes and requires final electrical as-built documentation.

#### **1.6 WORK AND MATERIALS INCLUDED BY CARMA CORP. – THE METER MANAGER™ SYSTEM SUPPLIER**

- .1 Supply, test and commission a METER MANAGER™ computer based electronic utilities submetering system as specified herein and shown on the Drawings.
- .2 The System is to include submetering data collection and communications with a Central PC and billing software or Local Display integral to the Field Panel.
- .3 The System is to be capable of handling a minimum of 2000 utility submetering points which include Electricity, Natural Gas, Water, Fluid Flow and BTU Measurement.
- .4 The System will be complete with all necessary:
  - .1 Electronic Field Panels - Energy Monitoring Pods (EMP), Data Collection Units (DCU) and Profilers (Pulse Totalizers);
  - .2 Current Transducers (CT);
  - .3 5AMP Step-Down Current Transformers (SDCT) and Meter Interface Devices (MID);
  - .4 Potential Transformers (PT);
  - .5 System Software;
  - .6 Network Interfaces and Network Repeaters;
  - .7 Integration of pulse output water, gas, fluid flow or BTU meters (form A (or C) contact closure or driven pulse type) [specification confirmed by Mechanical Consultant and supplied by mechanical contractor]

## DIGITAL METERING

- .5 The System Suppliers' price will include all costs associated with the co-ordination of system installation, material supply, commissioning, installation verification, and customer training during the entire period of construction and system start-up.
- .6 The System Supplier will provide a detailed installation manual to the electrical subcontractor, which recognizes all applicable codes and requires final electrical as-built documentation.
- .7 The System Supplier will include in the price all costs associated with Measurement Canada Bench Verification and Sealing, which confirms Measurement Canada Approval and for CSA inspection and certification. For electricity, Measurement Canada's minimum accuracy standard is 0.5% applicable at unity power factor, throughout the specified range of each current transducer and step-down current transformer. Electricity meters are required for electrically powered mechanical loads such as Air Handler Units, Chillers, etc.
- .8 The System Supplier shall include in the price all costs associated with Measurement Canada installation inspection and verification for all submeters. Installation inspection certificates shall be included in the as-built documents.

### 1.7 WORK AND MATERIALS INCLUDED BY THE ELECTRICAL CONTRACTOR

#### .1 ELECTRICAL CONTRACTOR RESPONSIBILITIES

Legend	
CT: Current (to-Voltage) Transducer (6.2V Output)	PT: Potential Transformer
SDCT: Step-down Current Transformer (5A Output)	EMP: Energy Monitoring Pod
MID: Meter Interface Device (5 A Transducers)	DCU: Data Collection Unit
Carma 422-LAN: RS-422 Local Area Network	Ethernet/WAN: Internet Based Networks
PMD: Pulse-Output Meter Device (water, gas, BTU)	Profiler: Pulse Totalizing Panel

**NOTE: It is the Electrical Contractor's responsibility to ensure all Electrical Codes and Safety Regulations (CSA/UL) are followed in the installation.**

#### **Equipment:**

Supply All:

- .1 Conduit for communications network cable and CT and PT leads.
- .2 Interconnecting cables: Carma-422LAN, CT or PT lead extensions if required (CTs and PTs come with 10 ft. (600V) leads). Acceptable types include: Beldon 8777 (300V), Provo FT4-1753-Stranded (600V), Provo FT6-991753-Stranded (600V). CAT-5 cable will be required for Ethernet systems. Single twisted-pair #22 cable for terminating PMDs to Profilers.
- .3 Connectors, fasteners and junction boxes for conduit, connectors for cable splices.

#### DIGITAL METERING

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- .4 Additional PT fuse blocks and fuses if PTs not installed within 10 ft (3m) of source. PT fuse block should be separately breakered at source and locked-on.
- .5 Supply 12 gauge wire for powering PT fuse block and SDCT current loops. See note below. Connections at splices must be crimped.

**Performance of Installation:**

- .6 Install and terminate communications cable between all network devices. This may also require connection to an onsite computer (or DCU). [Carma Technician will make the final connection to computer, but cable must be brought to computer (or into DCU) by installer]
- .7 Provide a dedicated 120VAC circuit for EMPs, Profilers, Repeaters and/or DCUs/Main Computer.
- .8 Mount any EMPs, Repeaters, Profilers, and DCUs (away from vibration or water threat)
- .9 Install PTs and connect each to the proper phase as per the EMP wiring chart using colour coded (red/black/blue) wire on the line side of the fuse blocks. PTs must be installed within 10 ft (3m) of their power source unless the line is fused at 15A or less.
- .10 Ensure conductors from PT fuse block to source or 5A SDCT current loop Do Not Pass Through CTs.
- .11 Hang all CTs on insulated conductors (and secured as required), phases corresponding to their assigned PTs, as per the EMP wiring chart, including verification of phase between PTs and CTs, and phase tape conductors.
- .12 Pre-inspect, measure physical spacing and identify model number (size) step-down current transformers (SDCTs). SDCTs are used for critical services or services over 400A.
- .13 Install any SDCTs (per above) and Meter Interface Devices/5AMP Transducers required, including shorting terminals with each current transformer (provided by TB2 in MID), using colour coded wiring from the current transformer to the shorting terminal and further to the transducer terminals (see MID installation figures for colour code and connections).
- .14 Terminate CT/PT/PMD leads on correct terminals of EMP/Profilers sensor board (as per EMP wiring chart) and, where necessary, extend leads with proper cable (as per "C" in Equipment above)
- .15 Ensure that EMP/PT/MID enclosures are not used as "Raceways" for other wiring
- .16 Ensure that the white dot (H1) on the CTs/SDCTs points toward the power source and that all CT/PT leads are connected to sensor boards according to the lead colours specified on the wiring charts.

#### DIGITAL METERING

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- .17 Ground CT/PT lead extension shields at EMP only (network shield only grounded at computer)
- .18 Provide details of physical locations of PTs/CTs/SDCTs in building and identify power sources for auxiliary EMP powers in Carma As-Built Forms
- .19 Ensure that CTs/SDCTs and PTs are accessible with identification tags visible, serial numbers facing outward, for installation inspection purposes by Measurement Canada personnel
- .20 Additional Requirements: Comply with all requirements identified in the Meter Manager™ Installation Manual, Measurement Canada Specification PS-E-04-E and 100% accurate and complete As-builts

### 1.8 SUBMITTALS

- .1 Submit dimensioned drawings and manufacturers' data of the DMS components including but not limited to digital meter, pulse data logger, network controller, meter enclosure
- .2 Submit shop drawings in accordance with Division 26 – Electrical General Provisions & 23 – Mechanical General Provisions for:
- .3 Verification credit EAc5.
  - .1 Interconnecting wiring diagram for the completely installed DMS.
  - .2 Data sheets for each system component.
  - .3 Operation and Maintenance manual.
- .4 Shop drawings must be submitted to Jain Consultants for review. Any deficiencies in the shop drawings must be resolved in order to achieve the LEED Measurement and Verification credit EAc5.
- .5 Submit shop drawings and manufacturer's data for the component items shown and specified under this section of the specification. Do not supply any equipment to this project prior to shop drawing review by the Consultant. Shop drawings shall be stamped and signed by the Contractor prior to submittal.
- .6 Submit a one-line diagram of the proposed system configuration for review.
- .7 After shop drawing review, the Approved Drawings will be issued to the Electrical and Mechanical Contractor(s) for installation.
- .8 At the completion of the Project, As-Built Drawings will be submitted by the DMS Supplier, who will prepare a complete manufacturer's manual including all As-Built Wiring Diagrams.

### 1.9 COMMISSIONING & TRAINING

- .1 After completion of the system testing, the Manufacturer shall conduct training of the Owner's operating and maintenance staff. Training will include both hardware items and computerized system operation.

## DIGITAL METERING

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### 1.10 CERTIFICATION AND APPROVALS

- .1 Measurement Canada approvals will consist of “Approval of Type” documentation submitted to the Consulting Engineer at the time of Tender closing as issued by Measurement Canada in Ottawa. Bench Verification of each submetering system device will be conducted by Accredited Measurement Canada Inspectors. Measurement Canada (a department of Industry Canada) enforces measurement of all commodities listed under the Electricity & Gas Act and Weights & Measures Act.
- .2 Measurement Canada Seals will be affixed to each field metering panel and shown to the final inspection Consultant.
- .3 Completion of on-site installation inspection and verification will be required by Measurement Canada under Specification PS-E-04
- .4 CSA approvals and panel stickers will be visible on each field panel.

### 1.11 SUBMETERING SYSTEM REQUIREMENTS

The following requirements must be functional capabilities of the submetering system at the time of Tender Closing. All requirements will be fully enabled for every meter.

- .1 Operation
  - .1 Shall provide automated monitoring and recording of Electrical, Services through a hardwired communications trunk cable. Measure and report energy consumption and demand of all electrical and mechanical meters installed and connected for:
    - .1 Electricity – specified by Electrical Engineering Consultant and/or CARMA CORP.
      - .1 3 phase, 4 wire 120, 240, 277 & 347 VAC
      - .2 2 phase, 3 wire 120/208VAC and “single-phase” residential 3-wire 120/240VAC
      - .3 3 phase, 3 wire (delta connected) 416, 480 & 600 VAC
  - .2 Shall provide Windows™ based software to accommodate blended utility rate structures including up to (24) twenty-four distinct daily intervals and (4) four seasonal registers for Time of Use and Tenant Meter. Provide for the generation of individual, custom Tenant Bills showing a clear breakdown of the calculations incorporated to allocate the main monthly utility invoice, Time of Use and Consumption to each Tenant.
  - .3 Shall permit totalizing of kWh and Demand measures (electricity) within the software, from any number of metering points and any meter groups required.

#### DIGITAL METERING

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- .4 Shall store 15-minute consumption and demand interval power measurement data for each meter, in non-volatile memory located in all field metering panels (Energy Monitoring Pods and Profilers), for a minimum period of 35 days.
- .5 Shall permit the following data to be transmitted from all metering points to the Central Computer for legal billing:
  - .1 Meter address;
  - .2 Electricity
    - .1 kWh (accumulated);
    - .2 Peak kW (demand) since last reset;
    - .3 Peak kVA (demand) since last reset.
  - .3 Mechanical
    - .1 Usage (accumulated);
    - .2 Peak Interval Usage (demand);
  - .4 15-minute interval data for construction of the Coincident Demand measures.
- .2 Supervision
  - .1 Shall run continuous self-diagnostics on the system and report on any tampering, communication interruptions and/or power failures.
  - .2 Shall provide password protection within the system software, with three levels of controllable access:
    - .1 Supervisor;
    - .2 Manager;
    - .3 User.
- .3 Communication
  - .1 Shall be via a twisted, shielded 3-pair 22-AWG cable (i.e. Belden #8777) cable interconnecting the Electronic Field Panels and repeaters to the Central Computer, following recognized industry standard requirements for the installation of a multi-drop linear communications (network) trunk cable.

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DIGITAL METERING

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**PART 2 - PRODUCTS**

**2.1 DRIVERS FOR LED FIXTURES**

- .1 Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:

**2.2 ELECTRONIC FIELD PANELS**

All submetering system panels and enclosures will be CSA approved and will display CSA approval labels.

- .1 Units shall:
  - .1 Be supplied in enclosures suitable for surface wall mounting and shall be complete with knockouts for conduit entry.
  - .2 Contain a non-volatile memory;
  - .3 Be tamper-proof;
  - .4 Be complete with automatic self test and diagnostic features;
  - .5 Contain a crystal based clock for the accurate calculation of kWh and demand intervals;
  - .6 Have a unique individual address;
  - .7 Be designed to retrieve information from field devices up to 2000 feet away;
  - .8 Provide connections for local interrogation of the unit utilizing a laptop computer;
    - .1 Be bench verified and sealed by Measurement Canada for legalized submetering.
    - .2 Allow Measurement Canada Approved field panel electronics to be fully removable without disconnecting any electrical terminations.

**2.3 ENERGY MONITORING PODS (EMP)**

- .1 Units shall:
  - .1 Be designed to measure and transmit Instantaneous RMS voltage and amperage for each phase;
  - .2 Be designed to measure and transmit Instantaneous, present and peak kW, kVA demand for the purposes of power-factor measurement (features enabled for whole building or large loads as required);



## DIGITAL METERING

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- .3 Be designed to measure and transmit kWh energy consumption on a minimum of 1 reading per day (or 24 readings per day for Time of Use applications). Meters may be read faster by a logger through building automation interface (as required)
- .4 Be equipped with terminal blocks to accommodate all necessary connections for current transducers, potential transformers and communication cables. For larger step-down current transformers, terminal blocks shall be complete with shorting connections.
- .5 Optionally, provide 100% additional spare meters for future expansion of the system. Spare meters will be installed evenly throughout the Project. Spare meters will be mounted in electrical rooms, supplied with 120 volt grounded power and referenced to potential transformers installed in the same locations. Step-down Current transformers & current transducers will be provided as required.

### **2.4 CURRENT TRANSDUCERS AND STEP-DOWN CURRENT TRANSFORMERS**

- .1 Sized to accommodate the following electrical service sizes:
  - 1. 100 amperes;
  - 2. 200 amperes;
  - 3. 400 amperes.
- .2 Certified by Measurement Canada for legalized Tenant Revenue-Billing.
- .3 For services larger than 400 amperes, Measurement Canada Approved step-down current transformers, each with a 5 ampere secondary will be provided with the required interface to the submetering system. A meter interface device shall expedite the meter commissioning without tools or the need for a power shutdown.
- .4 To be equipped with pre-wired leads, three (3) metres in length, on all Current Transducers sized at 400 amps or smaller.

### **2.5 POTENTIAL TRANSFORMERS**

- .1 Shall be suitable for voltage ratings required for the electrical system operation.
- .2 Shall be certified by Measurement Canada for legalized submetering.
- .3 Shall be factory assembled and mounted in separate enclosures complete with electrical disconnects and fuses.

### **2.6 SYSTEM SOFTWARE**

- .1 Provide a Windows™ based simplified user interface for system operation.
- .2 Revenue legal metering measurements shall be received from all submetering sensors and stored in a central Data Collection Unit (DCU) or PC in comma separated variable (CSV) file format.

## DIGITAL METERING

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- .3 To monitor, acknowledge and control communications with the remote metering points and to log any disruption of the communication link or unauthorized system access or tampering.
- .4 The system must be capable of storing all meter data for at least 36-months
- .5 All meters on the system must be capable of reporting hourly, daily, monthly and annually for their energy/utility usage
- .6 To permit the user to view instantaneous readings of voltage, current, power, phase angle, present and peak demand for any electricity meter.
- .7 To permit the user to view instantaneous readings present usage (totalized) or demand (last 15 minute interval) for any mechanical meter.
- .8 Provide the ability to export data into Reporting Applications (e.g. Web and Excel VBA).
- .9 To include service menus for diagnostic monitoring of the metering equipment and through either a modem and telephone link or Internet access to permit remote diagnostics by the manufacturer's service technicians. Security access control shall permit remote diagnosis to be locked out.
- .10 Data must be remotely accessible.

### 2.7 OUTPUT FILE FORMAT & STORAGE

- .1 Data shall be recorded every 15 minutes.
- .2 Data shall be provided in comma separated value (.CSV) files.
- .3 Each row in the output file shall represent a successive sample time.
- .4 Include a time stamp for each line in the file.
- .5 Separate each field by a single comma character.
- .6 Each required monitoring point shall contain a unique and understandable identifier.
- .7 Each required monitoring point shall contain a unique and understandable column.
- .8 All output files are to follow the format shown in Appendix B as closely as possible.
- .9 Provide a sample output data file a minimum of 1 month prior to building occupancy.
- .10 Provide data files to the Owner and LEED® consultant in electronic format.

### 2.8 DATA STORAGE AND LOGGING REQUIREMENTS

- .1 System shall be capable of storing data for a minimum of 250 DMS points (where power and energy measurements are equivalent to one point) for period of no less than 15 months.

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DIGITAL METERING

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**2.9 PULSE DATA RECORDER/PULSE TOTALIZER (PROFILER)**

- .1 Units shall:
- .2 Be capable of counting pulse inputs from eight (8) independent sources such as gas, water and electricity meters at up to 10 pulses per second (10 Hz).
- .3 Date, time stamp and store up to 30-days of 15-minute utilities interval data for all 8 channels.
- .4 Be designed to communicate on Modbus, RS-422 or RS-485 Local Area Network or stand alone through an on board dial up modem, Ethernet or wireless Ethernet 802.11b/g interface by a PC running digital metering software to retrieve interval data.

**2.10 FIELD METERS**

- .1 Shall be able to measure demand (KW), consumption (KWh), and usage (cubic meters, cubic feet, BTU's, etc.).
- .2 Shall be equipped with a pulse output and visual read out.
- .3 Power supply requirements: Self-powered
- .4 Shall be suitable for flow rate, pressure and temperature, and pipe size required for the mechanical system operation.
- .5 Accuracy: +/- 0.5% of 100% registration at 1.0 p.f., 1% to 100% load. It shall meet Measurement Canada accuracy requirements.
- .6 Operating Temperature: -40 deg. C to +55 deg. C
- .7 Electrical Meters
  - .1 Electrical meters shall be provided by Division 26.
  - .2 Voltage rating: 347/600V 3ph 4w or 600v 3ph 3w
  - .3 Operating frequency: 60 Hz
  - .4 Power factor range: 0.5 to 1.0 lead/lag
  - .5 Electrical meters shall be revenue grade (1% accurate) but do not need to be sealed for the purposes of M&V.
  - .6 Communications cable from meters to DMS computer location shall be provided by Division 26.
  - .7 All electrical meters, including the main incoming service meters, shall be inter connected by a network connected to the DMS computer.
  - .8 Provide interface equipment as required to connect the electrical meters to the DMS computer.

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**DIGITAL METERING**

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- .8 Gas, BTU and Water Meters
  - .1 Gas, BTU and water meters shall be provided by Mechanical Contractor.
  - .2 Gas, BTU and water meters shall be revenue grade (1% accurate) but do not need to be sealed for the purposes of M&V.
  - .3 Communications cable from meters to DMS computer location shall be provided by Electrical Contractor.
  - .4 All gas, BTU and water meters, including the main incoming service meters, shall be inter connected by a network connected to the DMS computer.
  - .5 Provide interface equipment as required to connect the gas, BTU and water meters to the DMS computer.

**2.11 ACCEPTABLE MANUFACTURERS**

- .1 CARMA CORP.
- .2 Schneider Powerlogic
- .3 Power Measurement ION
- .4 Triacta/Schneider PowerHawk
- .5 Approved Alternate

**2.12 LIST OF FIELD METERS**

- .1 Provide Project Specific Meter List and Metering Requirements
  - .1 Electricity: Voltages, Currents, 3ph/3w or 3ph/4w

**2.13 SYSTEM ARCHITECTURE**

- .1 See Appendix A.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- .1 The installation of the metering equipment shall be performed by licensed electricians, under the direct supervision of factory trained personnel.
- .2 Install meters as indicated on drawings/tender documents.
- .3 Division 23 is responsible for installing gas, BTU and water check meters capable of integration into the DMS network and equipped with visual read out.

## DIGITAL METERING

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- .4 Electrical Contractor is responsible for providing a connection (including all the rough-ins, ie. Conduits, wiring, etc.) from the gas, BTU and water check meters to the digital metering system location.
- .5 Division 26 is responsible for installing electric meters capable of integration into the DMS network.
- .6 Division 26 to coordinate with Division 23 for the installation of all the meter interconnections to the DMS. All wiring shall be completed by Division 26 as per specifications. All wiring will be done in accordance with Canadian National Electric Code standards and regulations, and in conjunction with the local Electrical Safety Association office.
- .7 Size and colour code wiring according to manufacturer's recommendations. All wiring shall be CSA approved and rated for 600V for low voltage conditions and 300V for extra low voltage conditions. Communication wiring shall be installed in twisted pairs to prevent interference from outside sources.
- .8 All current transformers will be installed with shorting switches so meters can be removed without high voltage electrical hazard.

### 3.2 CALIBRATION

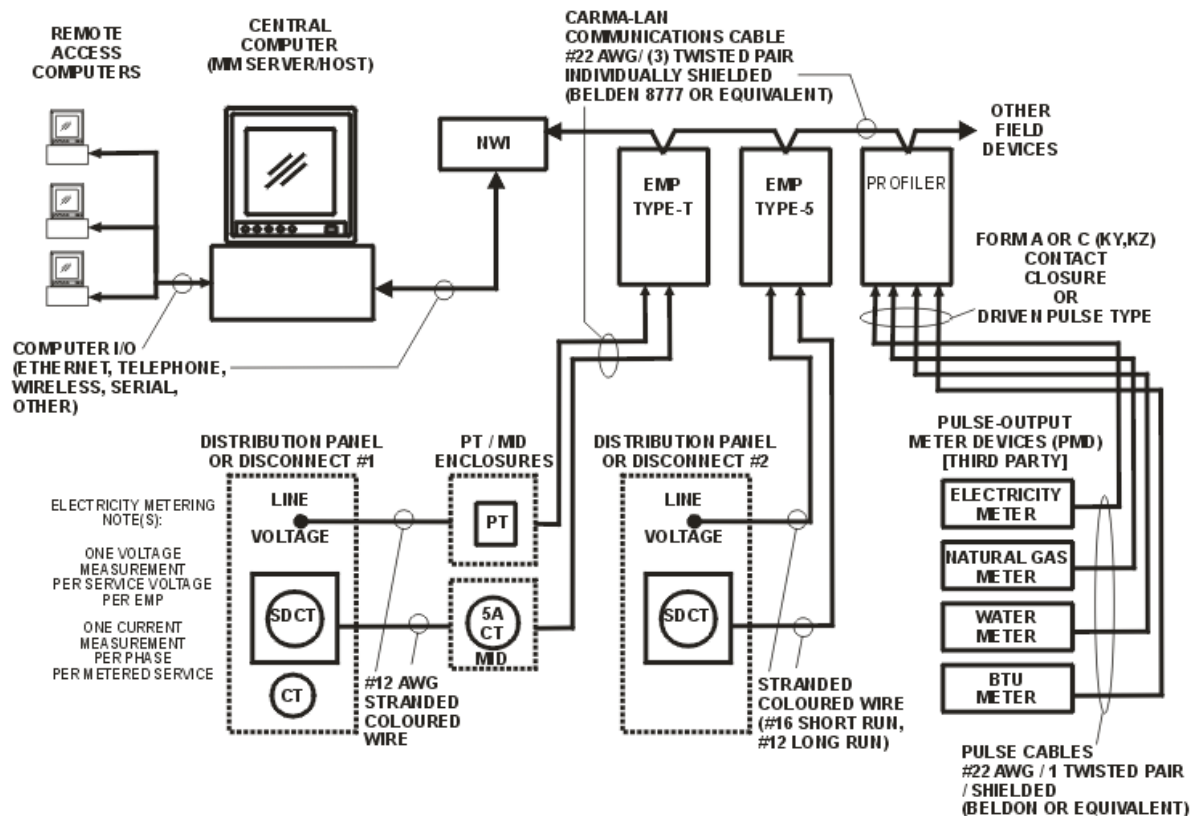
- .1 Setup meters according to manufacturer's instructions.
- .2 Commission the system to the satisfaction of the Measurement and Verification consultant and demonstrate the proper functioning of the system.
- .3 Provide a 3 hour training session to the owner's staff and Measurement and Verification consultant.
- .4 Provide Measurement & Verification consultant with remote access to the system.
- .5 Typical system architecture: The typical system architecture for a DMS is included in Appendix A for reference purposes.

### 3.3 WARRANTY

- .1 All equipment shall be free from defect in materials and workmanship under normal use and service for the period of twelve (12) months from the date of substantial completion.
- .2 All equipment will be verified by a factory-trained technician and certified for its Revenue Class accuracy.
- .3 A certificate shall be issued on final completion to confirm that the system is operating according to specifications.

## DIGITAL METERING

### 260923 - APPENDIX A: SYSTEM ARCHITECTURE



#### Terms

NWI	• NETWORK INTERFACE (COMMUNICATIONS METHOD CHANGES)
EMP	• ENERGY MONITORING POD
PROFILER	• PULSE TOTALIZING PANEL
PT	• POTENTIAL TRANSFORMER (120V, 347V, 600V OR OTHER)
CT	• CURRENT TRANSDUCER (100A, 200A, 400A)
MID	• METER INTERFACE DEVICE (5A CT'S)
SDCT	• 5AMP STEP-DOWN CURRENT TRANSFORMER
	• (SERVICES >400A OR CRITICAL LOADS)

#### NOTES:

- Schematic diagram indicates the typical components that make up a particular Meter Manager™ Submetering System installation.
- PTs and CTs measure voltage and current (respectively), allowing EMP's to calculate electricity consumption. For services over 400A, or critical loads, Measurement Canada Approved SDCTs (Current/Instrument Transformers) are installed on the service and connected to a MID (5 or 10 AMP CTs)
- Third Party Electricity, Natural Gas, Water and BTU (heating energy) meters are integrated into the system by Profiler Panels through pulse outputs.
- Central System (HOST computer/DCU) collects data/meter readings from the EMP's and Profilers on the CARMA-LAN. This can be either onsite or at a remote location.
- Remote access to the system can be made through a vast number of methods, including: Ethernet (WAN /Internet/VPN), telephone line and more.

DIGITAL METERING

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**260923 - APPENDIX B: SAMPLE M & V OUTPUT FILE FOR ELECTRICAL METERING**

<b>Date / Time</b>	<b>KWh</b>	<b>KW</b>	<b>kVA</b>
8/29/2008 1:00	14027.17	7.5	0.3
8/29/2008 1:15	14025.2	8.1	0.8
8/29/2008 1:30	14023.2	7.3	1.0
8/29/2008 1:45	14021.4	5.3	1.0
8/29/2008 2:00	14020.0	3.5	1.0
8/29/2008 2:15	14019.1	2.4	0.9
8/29/2008 2:30	14018.5	1.9	0.8

END OF SECTION

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SERVICE

---

CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
-------------------	--------------

PART 1 – GENERAL

1.1	Summary
1.2	Scope
1.3	Submittals

PART 2 - PRODUCTS

2.1	Main Service Breaker c/w Enclosure
-----	------------------------------------

PART 3 - EXECUTION

3.1	System Coordination and Short Circuit Study
3.2	Arc Flash Protection
3.3	Inspection and Test
3.4	Primary & Secondary Duct Banks
3.5	Transformer Foundation, Grounding & Bollards
3.6	Electrical Service
3.7	Secondary Cables



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SERVICE

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**PART 1 - GENERAL**

**1.1 SUMMARY**

- .1 This Specification Section is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with general condition, Supplementary Conditions, Section 26 01 00 – Electrical General Requirements

**1.2 SCOPE**

- .1 Hydro connection/service fee will be paid as a Cash Allowance item. Refer to Section 01 21 00 - Allowances.
- .2 Provide Hydro service as required and in accordance with Hydro requirements. Contractor shall coordinate with Hydro for more information and details related to Hydro incoming service and shall comply accordingly.
- .3 Electrical contractor to include fees for all inspection and/or testing as required by the Electrical Safety Authority.
- .4 Warning signs shall be fastened to each piece of apparatus as may be required by Hydro One and Electrical Safety Authority.
- .5 Obtain the approval from Hydro One and the Electrical Safety Authority on complete service.
- .6 Retain a testing company to carry out coordination and short circuit study, arc flash hazard study and calculation, testing and checking as listed herein. Provide correction and maintenance on the system to direction of the testing and checking results.
- .7 Duct banks and underground cables including terminations.
- .8 Foundation and pad for pad mounted hydro transformer c/w grounding as per Hydro requirements.

**1.3 SUBMITTALS**

- .1 Submit all required documentation to the ESA for approval.
- .2 Submit the coordination study for review to:
  - .1 Consultant.
  - .2 Electrical Safety Authority, if required.

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SERVICE

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- .3 Following completion of all inspection, testing and commissioning, submit a report prepared by the testing company to include but not limited to:
  - .1 All results recorded and referenced to the various sections of the electrical systems.
  - .2 Comments and recommendations where variations occur to the co-ordination study or accepted testing and performance values.
  - .3 Thermal photography where abnormal heating conditions are indicated and repeated photographs following correction.

## **PART 2 – PRODUCTS**

### **2.1 MAIN SERVICE BREAKER C/W ENCLOSURE**

- .1 Main breakers shall be 3-pole manually operated, quick-make, quick-break, solid state, 100% rated breaker equipped with field-adjustable long time, field-adjustable short time and field-adjustable instantaneous trip settings.
- .2 Refer to electrical drawings and comply accordingly.
- .3 Provide NEMA enclosure for main breaker to suit application.
- .4 Acceptable manufacturers are:
  - .1 Schneider
  - .2 Cutler-Hammer
  - .3 Siemens

## **PART 3 - EXECUTION**

### **3.1 SYSTEM COORDINATION AND SHORT CIRCUIT STUDY**

- .1 Retain the services of an approved testing company (see subsection 3.1.4 below) to perform protective coordination study to establish optimum settings and selections for all protective devices. Provide system coordination study and short circuit study for HV switchgears and cables, power transformer, LV switchgears and cables, and emergency generator system.
- .2 The study shall illustrate:
  - .1 Study single line diagrams, 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.
  - .4 Thermal damage curves for cable, transformers, motors and the like.

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SERVICE

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- .5 Summation chart showing all ratings and settings referenced to the appropriate time-current characteristic curve.
- .3 Provide all circuit breakers and protective devices with relays, trip settings, frame sizes and short circuit withstand ratings as determined from the co-ordination study.
- .4 Acceptable testing companies:
  - .1 Brosz and Associates
  - .2 G.T. Woods
  - .3 Cutler-Hammer (by Eaton Corporation)
  - .4 Schneider Electric
  - .5 Siemens Canada

**3.2 ARC FLASH PROTECTION**

- .1 Retain the services of an 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.

**3.3 INSPECTION AND TEST**

- .1 Systems, equipment and all major items required in coordination study 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 the ESA.
- .2 Have the testing company retained for the coordination study carry out pre-service and in-service testing and checking as listed herein.
- .3 The Owner reserves the right to retain, on his behalf, an independent testing company to witness the testing and to provide duplicate verification tests and any additional tests deemed necessary to ensure safety and proper operation of the system. Cooperate in every respect with the Owner's testing company and provide assistance as required to facilitate the testing work.

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SERVICE

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- .4 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.
- .5 Tests shall include but are not limited to the following:
  - .1 Visual inspections to ensure there are no obvious defects and determine adherence to allowable manufacturing tolerance and compliance with the manufacturer's recommended installation requirements.
  - .2 Proper operation tests of all systems and devices.
  - .3 Insulation tests and torque tests. High potential tests where recommended by the manufacturer.
  - .4 Test of all adjustable electrical protective devices of switchgear to establish calibration and operation in accordance with specifications and approved coordination curves.
  - .5 Calibration setting, and test-tripping, of all protective relays and devices, using "Primary-injection" equipment, in accordance with the approved coordination schedule.
  - .6 Grounding tests and phasing inspections.
  - .7 Test of all alarm devices and contacts.
  - .8 Inspections after system is energized shall include infrared thermographic examination of current carrying parts in switchgear, transformers, busways and all bolted connections for feeders. Submit a written report on the infrared testing to the Consultant.
  - .9 The Contractor shall cooperate with the approved testing company, open all equipment enclosures to permit inspection, and make good defective conditions.

**3.4 PRIMARY AND SECONDARY DUCT BANK**

- .1 Provide an underground primary duct bank as detailed to the padmount transformer base as directed on site, to provide for installation of primary cables by the Supply Authority. Construction details, routes and exact location of terminations shall be verified on the site with Hydro prior to installation commencing.
- .2 Provide a primary duct bank comprising PVC Type II CSA approved ducts (number of ducts as per drawings) to Supply Authority's approval, with minimum internal diameter of 104 mm, buried to a depth 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 25 mm (1") on all sides. The duct shall be on even grade, sloped not less than 76 mm (3") in 30 m (100 feet), and drained in accordance with Hydro regulations. All ducts shall be sealed with pipe caps during construction. The duct bank enclosure shall be steel reinforced as indicated. Provide Bell ends for all ducts.

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SERVICE

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- .3 Provide in each duct a 3/8" polypropylene Draw Rope, to facilitate the cable installation.
- .4 The ducts shall be encased in a red 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 1500 mm (5 ft.) length of duct shall be used. Ducts shall terminate to approval of Supply Authority.
- .5 The following inspections of the primary ducts shall be witnessed by the Supply Authority and Inspection Authority. Provide notification 48 hours prior to requested date of inspection.
  - .1 The complete run shall be inspected before the concrete encasement is placed.
  - .2 The duct run shall be 'proved' clear by pulling a 95 mm (3-3/4") mandrel wire brush and cleaning swabs through their complete length.
- .6 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.
- .7 Provide warning tapes for primary & secondary duct banks as per supply authority & latest OESC code & bulletins.
- .8 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 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.
- .9 Provide in each duct a 5/16" (8 mm) polypropylene Draw Rope, to facilitate the cable installation.
- .10 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.

**3.5 TRANSFORMER FOUNDATION, GROUNDING & BOLLARDS**

- .1 Provide a precast concrete foundation for installation of the padmount transformer in accordance with Supply Authority's Standards. Entire installation shall be to the satisfaction of Supply Authority and all other authorities having jurisdiction.

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SERVICE

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- .2 Provide a grounding system at the transformer and switchgear foundation in accordance with Supply Authority Standards. Provide #2/0 AWG copper conductor connected to building ground system.
- .3 All work in connection with the primary ducts, transformer and switchgear foundation shall be performed in strict accordance with regulations and the Supply Authority's details and requirements. Obtain approval of all details before commencing work.
- .4 Provide protection bollards at locations shown on drawings as per Supply Authority's Standards.

**3.5 ELECTRICAL SERVICE**

- .1 Provide complete electrical service as shown on the Drawings and as further described in this Section.
- .2 The Supply 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 Hydro regulations and the Supply Authority's requirements.
- .4 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.
- .5 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.
- .6 Provide indoor meter enclosure (10"D x 20"W x 30"H) and coordinate on Site for enclosure location, all to approval of Supply Authority.
- .7 Provide 19mm conduit for dedicated telephone line from telephone demarcation point to metering cabinet.

**3.6 SECONDARY CABLES**

- .1 Secondary cables shall be supplied and installed including secondary connections by Division 26.

END OF SECTION

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PANELBOARDS

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CONTENTS

SUBSECTION

TITLE

PART 1 – GENERAL

1.1	Summary
1.2	References
1.3	Submittals
1.4	Manufacturers

PART 2 - PRODUCTS

2.1	Ratings
2.2	Construction
2.3	Circuit Breakers
2.4	Fusible Switch Units
2.5	Equipment Identification

PART 3 - EXECUTION

3.1	Installation
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## PANELBOARDS

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### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- .1 This Specification Section is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with General Conditions, Supplementary Conditions, and Section 26 01 00 – Electrical General Requirements.
- .3 Provide factory assembled panelboards as herein specified and as shown on the Electrical Drawings.
- .4 Refer to the Electrical Drawings for: voltage; phase; size and type of mains; size, type and quantity of the branch devices; location; surface or flush mounting.

#### **1.2 REFERENCES**

- .1 Comply with the requirements of the latest editions of the following:
  - .1 CSA C22.2 No. 29 - Panelboards and Enclosed Panelboards.
  - .2 CSA C22.2 No. 5 - Molded Case Circuit Breakers.
  - .3 CSA C22.2 No. 4 - Enclosed and Dead-Front Switches.

#### **1.3 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 26 01 00 – Electrical General Requirements.
- .2 Shop drawings shall include electrical details and dimensions of panel, branch circuit device (breaker and switch) type, quantity and ampacity.

#### **1.4 MANUFACTURERS**

- .1 The manufacturer of the panelboards shall be the manufacturer of the major components within the assembly, including circuit breakers and fusible switches.
- .2 Acceptable manufacturers are:
  - .1 Cutler-Hammer – Eaton Corporation
  - .2 Schneider Electric
  - .3 Siemens Canada

### **PART 2 - PRODUCTS**

#### **2.1 RATINGS**

- .1 Panelboards rated 120/208 volt AC shall have short-circuit rating as shown on the Drawings, but not less than 10 kA RMS symmetrical.
- .2 Panelboards rated 347/600 volt AC shall have short-circuit rating as shown on the Drawings, but not less than 14 kA RMS symmetrical.



## PANELBOARDS

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- .3 Panelboards shall be labeled with the short-circuit rating.
- .4 Where series ratings are applied, provide the labels in accordance with the requirements of Electrical Safety Code. The labels shall state but not limited to:
  - .1 Size and type of upstream devices;
  - .2 Branch devices that can be used;
  - .3 Short-circuit rating.

### 2.2 CONSTRUCTION

- .1 Interiors shall be completely factory assembled devices.
- .2 Enclosure:
  - .1 Indoor dry locations: CSA type 1.
  - .2 Indoor sprinkler locations: CSA type 2.
  - .3 Outdoor locations: CSA type 3R.
- .3 Provide doors with concealed hinges, combined locks and latches for all panelboards except fusible disconnect switch type distribution panelboards.
- .4 Two (2) keys for each panelboard and key all panelboards alike.
- .5 Interior trim shall be dead-front construction to shield user from energized parts.
- .6 Main bus shall be tin finished high quality copper and extend the full length of the panel. Ground bus shall be sized to accommodate branch circuit grounding conductors. 200% neutral as required.
- .7 Sequence phase bussing with odd numbered sections on left and even on right, with each section identified by permanent number identification as to circuit number and phase.
- .8 Provide bolt-on type circuit breakers and/or disconnect switch units.
- .9 Minimum circuits shall be 42, unless otherwise noted in the Contract Documents.
- .10 Trims and doors shall be painted ANSI 61 grey. Factory applied paint finish on all exterior surfaces.
- .11 All required lugs.
- .12 Connectors for future breakers and switches. Drill and tap bus work.

### 2.3 CIRCUIT BREAKERS

- .1 Circuit breakers shall be quick-make, quick-break type, for manual and automatic operation, with over centre toggle handle. The handle shall reside in a position between "ON" and "OFF".
- .2 Circuit breakers shall have thermal and magnetic trip mechanism, to provide inverse time current tripping and instantaneous tripping, trip-free and trip indicating. Circuit breakers rated at 125A and larger shall have thermal and adjustable magnetic trip mechanism.

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## PANELBOARDS

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- .3 Multi-pole breakers shall be common trip type and have a common handle. Tie handles are not acceptable.
- .4 Clearly marked with their rated ampacity and respective trip rating and visible without removing bolted covers.
- .5 Provide handle locking devices on all branch circuit breakers controlling communication equipment, lighting control, exit signs, emergency lighting, fire alarm system and other life safety equipment.
- .6 Circuit breakers feeding unswitched lighting circuits shall be "switching duty" type.
- .7 Provide class 'A' ground fault protection with the circuit breaker, where required by the Electrical Safety Code.

### 2.4 FUSIBLE SWITCH UNITS

- .1 Refer to Section of 26 28 23 - Disconnect Switches.
- .2 Fusible pull-outs or door-operated type switches not acceptable.

### 2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Basic Materials and Methods.
- .2 Identify circuits controlled by each breaker on directory cards provided with panels. Directories shall be typed and mounted in metal frame with clear plastic cover.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- .1 Install panelboards securely, plumb, true and square, to adjoining surface.
- .2 Provide three (2) empty 35 mm (1 ¼") conduits from all recessed lighting and receptacle panelboards, terminated in ceiling space above.
- .3 Provide three (3) empty 53 mm (2") conduits from all recessed distribution panelboards, terminated in ceiling space above.

END OF SECTION

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WIRING DEVICES

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
<u>PART 1 – GENERAL</u>	
1.1	Summary
1.2	References
1.3	Submittals
1.4	Manufacturer
<u>PART 2 - PRODUCTS</u>	
2.1	Switches
2.2	Receptacles
2.3	Cover Plates
<u>PART 3 - EXECUTION</u>	
3.1	Installation

## WIRING DEVICES

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### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- .1 This Specification Section is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with the General Conditions, Supplementary Conditions, and Section 26 01 00 – Electrical General Requirements.
- .3 Provide all switches, receptacles, wiring devices, coverplates as required to complete the installation.

#### **1.2 REFERENCES**

- .1 Comply with the requirements of the latest editions of the following:
  - .1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Wiring Devices.
  - .2 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices.
  - .3 CSA-C22.2 No.55, Special Use Switches.
  - .4 CSA-C22.2 No.111, General-Use Snap Switches.
  - .5 CSA-C22.2 No. 144, Ground Fault Circuit Interrupters.

#### **1.3 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 26 01 00 – Electrical General Requirements.

#### **1.4 MANUFACTURER**

- .1 Wiring devices shall be manufactured by 1) Hubbell Canada ; 2) Pass & Seymour by Legrand Canada; 3) Bryant Electric. Catalogue numbers are referred below to indicate quality standard.

### **PART 2 - PRODUCTS**

#### **2.1 SWITCHES**

- .1 Switches shall be with following features:
  - .1 White premium specification grade, quiet type.
  - .1 Terminal holes approved for No. 10 AWG wire.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine moulding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 Fully rated for tungsten filament and fluorescent lamps.

## WIRING DEVICES

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- .2 Switches for 120 Volt lighting circuits
  - .1 Hubbell CSB115W, CSB315W and CSB415W, 15 ampere for single pole, three-way and four-way switching as required for the application.
- .3 Switches for motor or other control applications shall be horsepower rated, Hubbell, HBL7832D and HBL7810D 30Ampere for double-pole and three-pole for one application.

### 2.2 RECEPTACLES

- .1 Receptacles shall be with following features:
  - .1 White premium specification grade, urea moulded housing.
  - .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Break off links for use as split receptables.
  - .4 Eight back wired entrances, four side wiring screws.
  - .5 Triple wipe contacts and riveted grounding contacts.
  - .6 Impact-resistant nylon face.
  - .7 U-ground.
  - .8 Ground Fault Circuit Interrupter GFCI receptacles shall meet UL 943 requirements and be complete with self test and reset buttons, and LED indication light.
- .2 Duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR15WHI (CSA 5-15R).
- .3 Duplex receptacle, 20 amp, 120 volt, 1 phase, 2 pole, 3 wire, our, Hubbell, BR20WHI (CSA 5-20RA).
- .4 GFCI duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, GFST15W (CSA 5-15R).
- .5 GFCI duplex receptacle, 20 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, GF20STW (CSA 5-20RA).
- .6 Isolated ground receptacle, orange, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, IG5262 (CSA 5-15R).
- .7 Single 30 amp, 120 volt, 1 phases, 2 pole, 3 wire, Hubbell, HBL9308 (CSA 5-30R).
- .8 Single 30 amp, 120/208 volt, 2 phases, 3 pole, 4 wire, Hubbell, HBL9430A (CSA 14-30R).
- .9 Single 50 amp, 120/208 volt and 120/240 volt, 2 phases, 3 pole, 4 wire, Hubbell, HBL9450A (CSA 14-50R).
- .10 TVSS duplex receptacle, Gray, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, HBL5262GYWSA (CSA5-15R).
- .11 Tamper-resistant duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR15WHITR (CSA5-15R).

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WIRING DEVICES

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- .12 Weather-resistant duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR15WHIWR (CSA5-15R).

**2.3 COVER PLATES**

- .1 Stainless steel type 302, complete with matching screw.
- .2 Weatherproof covers shall be while-in-use type polycarbonate body, cover and plates, conform to NEMA3R. Hubbell # WP826MP.
- .3 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .4 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.
- .5 Water-tight hinged cover suitable for floor box for ganged receptacles, data/telephone outlets, finish to Consultant's directions.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- .1 Install single throw switches with handle in "UP" position when switch closed.
- .2 Install devices in gang type outlet box when more than one switch is required in one location. When supplied from different voltages or power sources, provide metal barriers in the ganged box.
- .3 Clean debris from outlet boxes.
- .4 Install devices plumb and level.
- .5 Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.
- .6 Adjust devices and wall plates to be flush and level.
- .7 Clean exposed surfaces to remove splatters and restore finish.
- .8 Test each receptacle device for proper polarity.
- .9 Test each GFCI receptacle device for proper operation.

END OF SECTION

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DISCONNECT SWITCHES

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CONTENTS

SUBSECTION

TITLE

PART 1 – GENERAL

1.1	Summary
1.2	Reference
1.3	Submittals

PART 2 - PRODUCTS

2.1	Disconnect Switches
2.2	Equipment Identification
2.3	Manufacturers
2.4	Fuses

PART 3 - EXECUTION

3.1	Installation
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**DISCONNECT SWITCHES**

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**PART 1 - GENERAL**

**1.1 SUMMARY**

- .1 This Specification Section is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with the General Conditions, Supplementary Conditions, and Section 26 01 00 – Electrical General Requirements.
- .3 Provide all disconnect switches, whether an integral part of equipment or separately mounted. Refer to the electrical drawings for switches' voltage, ampacity and number of poles.

**1.2 REFERENCE**

- .1 Comply with the requirements of the following (latest edition):
  - .1 CSA C22.2 No. 4, Enclosed and Dead-Front Switches.
  - .2 CSA C22.2 No. 39, Fuseholder Assemblies.
  - .3 CSA C22.2 No. 248 (Part 1 to Part 16), Low Voltage Fuses.

**1.3 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 26 01 00 – Electrical General Requirements.
- .2 Product data: switches' ratings and enclosure dimensions.

**PART 2 - PRODUCTS**

**2.1 DISCONNECT SWITCHES**

- .1 Enclosures:
  - .1 Indoor dry locations: CSA Type 1.
  - .2 Indoor sprinkler locations: CSA Type 2.
  - .3 Outdoor locations: CSA Type 3R.
- .2 Provision for padlocking in off switch position by locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated.
- .5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .6 Heavy-duty horsepower rated, quick-make, quick-break action, front operation, with integral handle mechanism and visible contacts in "OFF" position.
- .7 ON-OFF switch position indication on switch enclosure cover.
- .8 Switches identified for use as service equipment shall be labeled for this application.



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**DISCONNECT SWITCHES**

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- .9 Furnish solid neutral assembly and equipment ground bar.
- .10 Lugs suitable for copper and/or aluminum conductors.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section of 26 05 00 – Basic Materials and Methods.
- .2 Indicate name of load controlled.

**2.3 MANUFACTURERS**

- .1 Product of one manufacturer for entire project.
- .2 Acceptable manufacturers:
  - .1 Cutler-Hammer – Eaton Corporation.
  - .2 Schneider Electric.
  - .3 Siemens Canada.

**2.4 FUSES**

- .1 Fuses up to 600 volts and over 600amps:
  - .1 Where used in motor, transformer and other circuits with an inrush: Class L time delay. Ferraz Shawmut type A4BT or equal by Bussman.
  - .2 All remaining fuses: Class L non-time delay. Ferraz Shawmut Canada A4BY or equal by Bussman.
- .2 Fuses up to 600 volts and up to and including 600amps:
  - .1 Where used in motor, transformer and other circuits with an inrush: Class J time delay. Ferraz Shawmut type AJT or equal by Bussman.
  - .2 All remaining fuses: Class J non-time delay. Ferraz Shawmut Canada type A4J or equal by Bussman – Eaton Corporation.
- .3 Fuse storage cabinet: Wall-mounted sheet metal cabinet with shelves, suitable sized to store spare fuses and fuse pullers, complete with hinged door.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- .1 Install disconnect switches complete with fuses, if applicable.
- .2 In finished areas, where disconnecting devices are required, provide a circuit breaker in flush mounted enclosure.
- .3 Provide three spare fuses of each type and size used above 600 amp and six spare fuses of each type and size used up to and including 600amp.
- .4 Install fuses in mounting devices immediately before energizing circuit.

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DISCONNECT SWITCHES

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- .5 Ensure correct fuses is fit to physically match mounting devices.
- .6 Ensure correct fuse is fitted to assigned electrical circuit.
- .7 Mount the fuse storage cabinets on the wall in electrical rooms. Mount the spare fuses in clip neatly arranged and labeled.

**END OF SECTION**

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POWER GENERATOR – NATURAL GAS

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CONTENTS

SUBSECTION      TITLE

PART 1 – GENERAL

- |     |                                     |
|-----|-------------------------------------|
| 1.1 | Description of System & Site        |
| 1.2 | Requirements of Regulatory Agencies |
| 1.3 | Manufacturer Qualifications         |
| 1.4 | Submittals                          |
| 1.5 | Approved Manufacturer               |

PART 2 - PRODUCTS

- |      |                               |
|------|-------------------------------|
| 2.1  | Engine Rating and Performance |
| 2.2  | Engine Oil System             |
| 2.3  | Engine Cooling System         |
| 2.4  | Engine Starting System        |
| 2.5  | Engine Fuel System            |
| 2.6  | Engine Controls               |
| 2.7  | Engine Exhaust & Intake       |
| 2.8  | Alternator                    |
| 2.9  | Controls                      |
| 2.10 | Remote Annunciator Panel      |
| 2.11 | Engine / Alternator Packaging |
| 2.12 | Enclosure                     |
| 2.13 | Loose Items                   |
| 2.14 | Load Bank Breaker             |

PART 3 - EXECUTION

- |     |                      |
|-----|----------------------|
| 3.1 | Factory Testing      |
| 3.2 | Owner's Manual       |
| 3.3 | Installation         |
| 3.4 | Service              |
| 3.5 | Warranty             |
| 3.6 | Startup and Checkout |
| 3.7 | Training             |
| 3.8 | Substitutions        |

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POWER GENERATOR – NATURAL GAS

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**PART 1 - GENERAL**

**1.1 DESCRIPTION OF SYSTEM & SITE**

- .1 Provide a 250kW standby power system to supply electrical power at 120/208 Volts, 60 Hertz, 3 Phase. The generator shall consist of a liquid cooled spark-ignited engine, a synchronous AC alternator, and system controls with all necessary accessories for a complete operating system, including but not limited to the items as specified hereinafter.
- .2 The site is in Ontario location with no specific harsh environment requirements.
- .3 The genset shall be applied at the site ambient and elevation. Bidders to submit the generators rated accordingly.
- .4 Bidders are to submit the generator set sound level rated at 75 dBA at 7m at full load in a free field environment.

**1.2 REQUIREMENTS OF REGULATORY AGENCIES**

- .1 An electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested, as a complete unit, on a representative engineering prototype model of the equipment to be sold.
- .2 The generator set must conform to applicable CSA-C282-15 requirements for Emergency Power Supply in Buildings.
- .3 The generator set must be CSA certified.
- .4 The generator set must comply with CSA-B149-15 requirements for Natural Gas and Propane Installation Code.
- .4 The generator set must meet the latest revision of Ontario Regulation No. 524-98 requirements for standby generators including, but not limited to: 9.2 g/kW/hr NOx, vertically-discharging exhaust stack, 75dBa @ 7m noise level. Bidders are to verify the generator set complies with this regulation.

**1.3 MANUFACTURER QUALIFICATIONS**

- .1 This system shall be supplied by an original equipment manufacturer (OEM) who has been regularly engaged in the production of engine-alternator sets, automatic transfer switches, and associated controls for a minimum of 25 years, thereby identifying one source of supply and responsibility. Approved manufacturers are Kohler by Paramount Power System, Caterpillar by Toromont Industries and Cummins by Cummins Eastern Canada, Blue Star Power Systems by Gal Power and Generac by Total Power.

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**POWER GENERATOR – NATURAL GAS**

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- .2 The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication.
- .3 Manufacturer's authorized service representative shall meet the following criteria:
  - .1 Certified, factory trained, industrial generator technicians
  - .2 Service support 24/7
  - .3 Service location within 300 kilometers
  - .4 Response time of 4 hours
  - .5 Service & repair parts in-stock at performance level of 95%
  - .6 Offer optional remote monitoring and diagnostic capabilities

**1.4 SUBMITTALS**

- .1 Engine Generator specification sheet
- .2 Controls specification sheet(s)
- .3 Installation / Layout dimensional drawing
- .4 Wiring schematic
- .5 Sound data
- .6 Emission certification
- .7 Warranty statement

**1.5 APPROVED MANUFACTURER**

- .1 Kohler by Pritchard Power Systems or Paramount
- .2 Caterpillar by Toromont
- .3 Cummins Power by Cummins Eastern
- .4 Generac by Total Power

**PART 2 - PRODUCTS**

**2.1 ENGINE RATING AND PERFORMANCE**

- .1 The prime mover shall be a liquid cooled, 1800 RPM, spark-ignited, 4-cycle rich-burn natural gas engine. It will have adequate horsepower to achieve rated kW standby power (ESP) as defined by ISO 8528. Minimum accepted engine displacement is 11 Liters. Engines running higher than 1800 RPM will not be accepted.

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POWER GENERATOR – NATURAL GAS

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- .2 The engine shall support a 100% load step.
- .3 The generator system shall support generator start-up and load transfer within 15 seconds.
- .4 The generator shall accept a load step of 100% of rated kW with a maximum voltage dip of 35% and must recover both voltage and frequency to stable nominal values within 10 seconds.

**2.2 ENGINE OIL SYSTEM**

- .1 Full pressure lubrication shall be supplied by a positive displacement lube oil pump. The engine shall have a replaceable oil filter(s) with internal bypass and replaceable element(s).
- .2 The engine shall operate on mineral based oil. Synthetic oils shall not be required.

**2.3 ENGINE COOLING SYSTEM**

- .1 The engine is to be cooled with a unit mounted radiator, fan, water pump, and closed coolant recovery system. The coolant system shall include a coolant fill box which will provide visual and control panel monitored means to determine if the system has adequate coolant level. The radiator shall be designed for operation in 50 degrees C ambient temperature.
- .2 The engine shall have a unit mounted, thermostatically controlled water jacket heater(s) to aid in quick starting. The wattage shall be as recommended by the manufacturer.
- .3 Engine coolant and oil drain extensions, equipped with pipe plugs and shut-off valves, must be provided to the outside of the mounting base for cleaner and more convenient engine servicing.
- .4 A radiator fan guard must be installed for personnel safety that meets OSHA safety requirements.

**2.4 ENGINE STARTING SYSTEM**

- .1 Starting shall be by a solenoid shift, DC starting system.
- .2 The engine's cranking batteries shall be lead acid. The batteries shall be sized per the manufacturer's recommendations. The batteries supplied shall meet CSA-C282-15 cranking requirements. Battery specifications (type, amp-hour rating, cold cranking amps) to be provided in the submittal.

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**POWER GENERATOR – NATURAL GAS**

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- .3 The genset shall have an engine driven, battery charging alternator with integrated voltage regulation.
- .4 The genset shall have an automatic dual rate, float-equalize, 10 Amp battery charger. The charger must be protected against a reverse polarity connection. The charger's output shall be monitored within the generator controller to support remote monitoring and diagnostics. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.

**2.5 ENGINE FUEL SYSTEM**

- .1 The engine shall be configured to operate on pipe-line grade natural gas with a nominal heating value of 1000 BTU per cubic foot. The engine must be capable of starting and accepting full-load in a single-step at a gas inlet pressure of 7-11 inches H<sub>2</sub>O. Engines requiring higher pressures will not be accepted.
- .2 The engine shall utilize a fuel system inclusive of carburetor, gas regulator, low gas pressure switch, and dual normally-closed fuel shut-off solenoids.
- .3 The engines internal fuel connections shall be terminated to the generator frame via an NPT fitting for easy installation.

**2.6 ENGINE CONTROLS**

- .1 Engine speed shall be controlled with an integrated isochronous governor function with no change in alternator frequency from no load to full load. Steady state regulation is to be 0.25%.
- .2 Engine sensors used for monitoring and control are to be monitored by the generator set controller for sensor failure.
- .3 The engine shall include an OEM engine control module (ECM) to monitor and control the engine power and emission performance.
- .4 All engine sensor connections shall be sealed to prevent corrosion and improve reliability.

**2.7 ENGINE EXHAUST & INTAKE**

- .1 The engine exhaust emissions shall meet the Ontario emission requirements for standby power generators.

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POWER GENERATOR – NATURAL GAS

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- .2 The manufacturer shall supply its recommended stainless steel, flexible connector to couple the engine exhaust manifold to the exhaust system. A rain cap will terminate the exhaust pipe after the silencer. All components must be properly sized to assure operation without excessive back pressure when installed.
- .3 The manufacturer shall supply a minimum critical-grade exhaust silencer as standard. The silencer shall be selected to achieve site sound level criteria of 75 dBA @ 7m in free field.
- .4 For indoor installations, the silencer must include a condensate drain at the lowest point of the silencer. The contractor shall extend the condensate drain to the floor drain complete with a ball-valve. The generator supplier shall include thermal exhaust wrap for the rated temperature from the exhaust manifold through to the catalytic convertor (if so equipped). The contractor shall insulate the exhaust silencer and all post-silencer exhaust piping contained within the generator room to prevent over-heating of the generator room.
- .5 For gensets in a sound attenuated weather enclosure, all exhaust piping from the turbo-charger discharge to the silencer shall be thermally wrapped to minimize heat dissipation inside the enclosure. The silencer must be within the generator enclosure or cooling air outlet chamber.
- .6 The engine intake air is to be filtered with engine mounted, replaceable, dry element filters. Include an air-cleaner restriction indicator to aid with maintenance.

## **2.8 ALTERNATOR**

- .1 The alternator shall be the voltage and phase configuration as shown on the single-line diagram.
- .2 The alternator shall be a 4-pole, revolving field, stationary armature, synchronous machine. The excitation system shall utilize a brushless exciter with a three-phase full wave rectifier assembly protected against abnormal transient conditions by a surge protector. Photo-sensitive components will not be permitted in the rotating exciter.
- .3 The alternator shall include a permanent magnet generator (PMG) for excitation support. The system shall supply a minimum short circuit support current of 300% of the rating for 10 seconds.
- .4 Three phase alternators shall be 6 or 12 lead, broad range capable of supporting voltage reconnection. All leads must be extended into a NEMA 1 connection box for easy termination. A fully rated, isolated neutral connection must be included by the generator set manufacturer.



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POWER GENERATOR – NATURAL GAS

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- .5 The alternator shall use a single, sealed bearing design. The rotor shall be connected to the engine flywheel using flexible drive disks. The stator shall be direct connected to the engine to ensure permanent alignment.
- .6 The alternator shall meet temperature rise of 130 deg. C in a 40 deg. C ambient. The insulation system material shall be class "H".
- .7 The alternator shall be protected against overloads and short circuit conditions by advanced control panel protective functions. The control panel is to provide a time current algorithm that protects the alternator against short circuits. To ensure precision protection and repeatable trip characteristics, these functions must be implemented electronically in the generator control panel -- thermal magnetic field circuit breaker implementation is not acceptable.

## **2.9 CONTROLS**

- .1 The generator control system shall be a fully integrated microprocessor based control system for standby emergency engine generators meeting all requirements of CSA-C282-15 Table-1.
- .2 The generator control system shall be a fully integrated control system enabling remote diagnostics and easy building management integration of all generator functions. The generator controller shall provide integrated and digital control over all generator functions including: engine protection, alternator protection, speed governing, voltage regulation, air-fuel-ratio control (as required) and all related generator operations. The generator controller must also provide seamless digital integration with the engine's electronic engine control module (ECM) if so equipped. Generator controller's that utilize separate voltage regulators and speed governors or do not provide seamless integration with the engine management system are considered less desirable.
- .3 Communications shall be supported with building automation via Modbus-RTU protocol without network cards. Optional internet and intranet connectivity shall be available.
- .4 The control system shall provide an environmentally sealed design including encapsulated circuit boards and sealed automotive style plugs for all sensors and circuit board connections. The use of non-encapsulated boards, edge cards, and pc ribbon cable connections are considered unacceptable.
- .5 Circuit boards shall utilize surface mount technology to provide vibration durability. Circuit boards that utilize large capacitors or heat sinks must utilize encapsulation methods to securely support these components.
- .6 A predictive maintenance algorithm that alarms when maintenance is required. The controller shall have the capability to call out to the local servicing dealer when maintenance is required.

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POWER GENERATOR – NATURAL GAS

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- .7 Diagnostic capabilities should include time-stamped event and alarm logs, ability to capture operational parameters during events, simultaneous monitoring of all input or output parameters, and callout capabilities.
- .8 In addition to standard CSA-C282-15 alarms, the application loads should also be protected through instantaneous and steady state protective settings for system voltage, frequency, and power levels. The controller shall annunciate ATS Not in Auto or Bypass Mode for all Life Safety ATS's. The controller shall annunciate "Damper Fail" from a remote signal to indicate the intake damper is not 90-100% open after 15 seconds from receiving the start command. The control panel shall monitor the gas-valve(s) auxiliary switch and annunciate an alarm if any manual gas-valves in the generator fuel system are closed.
- .9 The control system shall provide pre-wired customer use I/O: 4 relay outputs (user definable functions), communications support via RS232, RS485, or an optional modem. Additional I/O must be an available option.
- .10 Customer I/O shall be software configurable providing full access to all alarm, event, data logging, and shutdown functionality. In addition, custom ladder logic functionality inside the generator controller shall be supported to provide application support flexibility. The ladder logic function shall have access to all the controller inputs and customer assignable outputs.
- .11 The control panel will display all user pertinent unit parameters including: engine and alternator operating conditions; oil pressure and optional oil temperature; coolant temperature and level alarm; fuel level (where applicable); engine speed; DC battery voltage; run time hours; generator voltages, amps, frequency, kilowatts, and power factor; alarm status and current alarm(s) condition.
- .12 The control panel shall include a DPDT run-relay for remote monitoring and damper control.
- .13 The control panel shall include a SPDT common-failure relay for remote monitoring.
- .14 The control panel shall include a relay board with 10 programmable SPDT output relays for customer use.

**2.10 REMOTE ANNUNCIATOR PANEL**

- .1 Provide a remote annunciator panel to be installed inside the building as indicated on drawings c/w conduits and wirings and as per System Supplier requirement c/w all accessories for a fully operation system. The remote annunciator panel shall include all brackets and parts required for flush-mount or surface-mount installations.

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POWER GENERATOR – NATURAL GAS

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**2.11 ENGINE / ALTERNATOR PACKAGING**

- .1 The engine/alternator shall be mounted with internal vibration isolation onto a welded steel base. These units shall not need external vibration isolation for normal pad mounted applications.
- .2 Thermal magnetic or electronic circuit breaker carrying the CSA mark shall be factory installed. The circuit breaker shall be clearly labelled "Generator Circuit Breaker". The breaker shall be rated for the maximum site design load current utilizing CSA 80% or 100% rated circuit breaker. The line side connections are to be made at the factory. The line side connections are to be made at the factory. Output lugs shall be provided for load side connections. The circuit breaker shall be equipped with an auxiliary contact wired to the control panel to indicate the breaker is not closed. Refer to electrical single-line drawing for more information.
- .3 A second circuit breaker shall be installed on the generator set in parallel with the above breaker. This breaker shall clearly be labelled "Load Bank Breaker". The circuit breaker shall be rated for the genset full-load resistive current. The load bank breaker shall be equipped with a shunt trip mechanism and wired to trip this breaker upon receiving a remote start signal from any ATS while the genset is being load bank tested to prevent the genset from being overloaded and ensuring full emergency power is available at all ATS's in the event of a normal power failure.
- .4 Genset installations accessible from exterior grade: The Load Bank Breaker load connections shall feature re-usable screw-type lugs for connecting load bank cables.
- .5 Genset installations that are not accessible from exterior grade: the output of the Load Bank Breaker shall be wired to an exterior-mounted load bank connection box supplied by the generator set supplier. This box shall be weather-protective and shall be clearly labelled "Generator Load Bank Connections – ensure this circuit is de-energized before connecting or disconnecting camlocks". The box shall offer in-use weather protection. This box shall also bear a label indicating the voltage, phase, and current protection level of the circuit. Sufficient quantity of female camlock connectors shall be provided for all phases and ground. This connection box must be electrically inspected by a CSA recognized authority. The electrical contractor shall supply and install a weather-protective non-fused safety-switch ahead of and located as near as practical to the load bank connection box. Apply a permanent weather proof label on the safety switch, "Ensure all camlocks are fully connected before energizing".

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POWER GENERATOR – NATURAL GAS

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**2.12 ENCLOSURE**

- .1 The generator set shall be shipped complete with a weatherproof and sound attenuated steel enclosure complete with interior mounted silencer. The sound enclosure shall be rated to limit the generator set noise to less than 75dBa at 7m in a free-field environment using acoustic insulation.
- .2 The enclosure shall be constructed of minimum 14-gage steel finished with UV resistant powder coat enamel of the manufacturer's standard colour.
- .3 The enclosure shall feature no less than 4-doors with stainless steel hinges and be key-lockable. Doors shall be positioned to allow service to all points of the generator set, breakers, and control panel.
- .4 Provide a load centre for the enclosure ancillary devices as listed below. Ensure the associated devices and wiring is inspected and labelled by a suitable electrical inspector such as ESA.
- .5 Include a schematic within the shop drawing submittal showing the load centre and each of these ancillary devices. Include a schedule showing that the loads are balanced and the minimum and maximum required power supply requirement including the preferred voltage and phase.
- .6 Contractor shall provide the required power supply from an overcurrent protected circuit fed from the load side of the automatic transfer switch.
- .7 Load centre shall be installed within the enclosure in Nema-1 enclosure or on the outside of the enclosure in a Nema-3R enclosure. If all ancillary devices provided require only single phase power (L-N or L-L) then a 125/250V 1-phase 3-wire load centre shall be supplied, suitable for either 120/240V or 120/208V single phase supply. If any ancillary devices (block heater, enclosure heater, etc.) require three phase power, then a 120/208V 3-phase panel shall be provided. The load centre shall be:
  1. Non-combination type.
  2. CSA or cUL certified.
  3. Push-On or StabLok type is acceptable where installed in a location that is isolated from the generator set vibrations. Otherwise, the load centre shall be bolt-on type.
  4. Shall be complete with individual feeder breakers for the ancillary devices. Ensure any blank spaces are provided with the load centre manufacturer specified blanks or covers.

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POWER GENERATOR – NATURAL GAS

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- .8 The following individual circuits and ancillary devices shall be provided as a minimum:
1. Engine block heater c/w thermostat sized as per engine manufacturer's recommendation. This circuit may be hard-wired directly to the block heater or to a dedicated block heater receptacle if the block heater is equipped with a pre-connected cord and plug. Ensure this dedicated receptacle is located close enough to the block heater to allow for slack in the cord when plugged in. Note: Hard-wired is the preferred method to reduce the possibility the block heater is inadvertently unplugged.
  2. Fan-forced enclosure heater complete with adjustable thermostat to maintain the enclosure interior at +10°C at all times when the engine is not running as appropriate for the enclosure size. In no case shall the heater be sized less than 1000W.
  3. Ensure thermostat is set at no less than 10°C and no more than 40°C.
  4. To maintain the enclosure temperature, positive ventilation dampers (motorized type) must be provided on all enclosure cooling-air intake openings. Cooling-air outlets shall also be fitted with motorized dampers where practical to do so.
  5. Battery charger.
  6. Minimum one (1) 120V-20A T-Slot GFCI commercial-grade receptacle located in a convenient location near the load centre. Purpose of this receptacle is to provide power for small power tools or trouble-light as might be required to troubleshoot or provide maintenance to the generator set. Note: This receptacle is in addition to the dedicated block heater receptacle (if provided).
  7. Lighting:
  8. AC lighting fixtures complete with guards or covers. Fixture type may be incandescent, cold-starting fluorescent, or Super-Bright LED. Quantity of fixtures and output wattage shall be sufficient to, and located such that, they provide adequate lighting at all service-points on the engine, control panel, and load centre. Fixtures shall be located or shielded to prevent damage to the fixture from excess-heat from the engine exhaust system. Where the engine is of the vee-type arrangement, fixtures shall be located on each side of the enclosure to illuminate service-points on both sides-of the engine without dark shadows. Provide minimum one (1) light switch located near the main control panel door.
  9. CSA-C22.2 No. 141 certified emergency lighting providing minimum 50 lux at all service points complete with battery pack providing minimum 2-hours of operation as per CSA-C282. Output from each emergency light shall be minimum twin 18W halogen or 17W LED. Note: Engine starting-battery fed DC lighting does not comply with this requirement.
  10. Light fixtures that offer both AC lighting and automatic switch-over emergency lighting as defined above shall be considered acceptable.

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**POWER GENERATOR – NATURAL GAS**

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11. Where motorized damper(s) are provided, they shall be of the drive-closed, fail-open type using heavy-duty quick-acting high-torque-spring mechanism. The ventilation damper motor circuit shall be wired through a normally-closed contact on the engine run relay to ensure dampers fully open within 30 seconds of a normal power failure or engine start command and that the intake damper remains open at all times the engine is running.
12. The intake damper or damper-motor shall be fitted with a position switch wired to the generator controller to alarm on "Damper Fail" if the intake damper is less than 85% open after 30 seconds.
13. Provide a minimum of one (1) spare 15-Amp single-pole circuit breaker for future use.

**2.13 LOOSE ITEMS**

- .1 Supplier to itemize loose parts that require site mounting and installation.
- .2 Flexible fuel hose approved for use in gas piping installation.

**2.14 LOAD BANK BREAKER**

- .1 Provide a second breaker installed on the generator set wired in parallel with the main generator circuit breaker. Clearly label this breaker "Load Bank Breaker - Do not energize unless all load bank connections are securely in place." This breaker shall be rated for the full resistive kW design load.
  - .1 Equip circuit breaker with a DC shunt trip mechanism wired to the generator control panel to automatically disconnect the load bank upon receiving a remote start signal from any automatic transfer switch in the event of a normal power failure occurring during a load bank test to prevent genset overloading.

**PART 3 - EXECUTION**

**3.1 FACTORY TESTING**

- .1 Before shipment of the equipment, the engine-generator set shall be tested under rated load for performance and proper functioning of control and interfacing circuits. Tests shall include:
  - .1 Verify all required safeties.
  - .2 Verify voltage & frequency stability. Verify transient voltage & frequency response upon application and removal of maximum site design load including recovery time.
  - .3 Load test the generator for 60 minutes.

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POWER GENERATOR – NATURAL GAS

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- .2 Provide a copy of the test reports for engineer review prior to shipment of the equipment to site. Consulting engineer reserves the right to witness the factory test.

**3.2 OWNER'S MANUAL**

- .1 Three (3) sets of owner's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

**3.3 INSTALLATION**

- .1 Contractor shall install the complete electrical generating system including all external fuel connections in accordance with requirements of ESA, TSSA, and the manufacturer's recommendations as reviewed by the Engineer.

**3.4 SERVICE**

- .1 Supplier of the genset and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing warranty and routine maintenance service to afford the owner maximum protection. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Service maintenance contracts shall also be available.

**3.5 WARRANTY**

- .1 The standby electric generating system components, complete genset and instrumentation panel shall be warranted by the manufacturer against defective materials and factory workmanship for a period of five (5) years. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge for parts, labor and travel.
- .2 The warranty period shall commence when the standby power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

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POWER GENERATOR – NATURAL GAS

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**3.6 STARTUP AND CHECKOUT**

- .1 The supplier of the generator set and associated items covered herein shall provide factory trained technicians to checkout the completed installation and to perform an initial startup inspection to include:
  - .1 Ensuring the engine starts (both hot and cold) within the specified time.
  - .2 Verification of engine parameters within specification.
  - .3 Verify no load frequency and voltage, adjusting if required.
  - .4 Test all automatic shutdowns of the engine-generator.
  - .5 Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using available building load for a period of 1-hour.
  - .6 Perform a maximum site design load test utilizing a portable resistive load bank for a period of 4-hours.

**3.7 TRAINING**

- .1 On a separate day, training is to be supplied by the start-up technician for the end-user. The training should cover basic generator operation, maintenance, and common generator issues that can be managed by the end-user, as well as how to report a generator failure that requires a repair technician.

**3.8 SUBSTITUTIONS**

- .1 The emergency power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel piping have all been sized and designed around Kohler model 250REZXB. Should any substitutions be made, the contractor shall bear responsibility for the installation, coordination and operation of the system as well as any engineering and redesign costs which may result from such substitutions. Alternate equipment suppliers shall ensure compliance with base spec unit. As part of the submittals, the substitute manufacturer shall supply as a minimum engine, alternator and control panel wiring diagrams and schematics.

END OF SECTION



LOW VOLTAGE BYPASS / ISOLATION  
AUTOMATIC TRANSFER SWITCHES

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CONTENTS

SUBSECTION

TITLE

PART 1 – GENERAL

1.1	Scope
1.2	References
1.3	Submittals – For Review / Approval
1.4	Submittals – For Information
1.5	Submittals – For Construction
1.6	Qualifications
1.7	Regulatory Requirements
1.8	Delivery, Storage and Handling
1.9	Operation and Maintenance Manuals

PART 2 - PRODUCTS

2.1	Manufacturers
2.2	Ratings
2.3	Transfer Switch
2.4	Bypass Isolation Switch
2.5	Microprocessor Logic Control
2.6	Wiring / Terminations
2.7	Enclosure
2.8	Finish
2.9	Transfer Switch Operation
2.10	Accessories
2.11	Optional Accessories

PART 3 - EXECUTION

3.1	Factory Testing
3.2	Installation
3.3	Field Quality Control
3.4	Manufacturer's Certification
3.5	Training
3.6	Field Service Organization

LOW VOLTAGE BYPASS / ISOLATION  
AUTOMATIC TRANSFER SWITCHES

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**PART 1 – GENERAL**

**1.1 SCOPE**

- .1 The Contractor shall furnish and install the low voltage automatic transfer switch and bypass isolation transfer switch having the ratings, features/accessories and enclosures as specified herein and as shown on the Contract Drawings.

**1.2 REFERENCES**

- .1 The automatic transfer switch and bypass isolation switches and all components shall be designed, manufactured and tested in accordance with the latest applicable CSA standards as follows:
  - .1 CSA 22.2 No. 178 – Automatic Transfer Switches
  - .2 CSA C282-05 – Emergency Electrical power Supply for Buildings
  - .3 CSA Z32 – Electrical Systems in Health Care Facilities

**1.3 SUBMITTALS – FOR REVIEW/APPROVAL**

- .1 The following information shall be submitted to the Consultant:
  - .1 Master drawing index
  - .2 Front view and plan view of the assembly
  - .3 Schematic diagram
  - .4 Nameplate schedule
  - .5 Component list
  - .6 Conduit space locations within the assembly
  - .7 Assembly ratings including:
    - .1 Short-circuit rating
    - .2 Voltage
    - .3 Continuous current rating
  - .8 Major component ratings including:
    - .1 Voltage
    - .2 Continuous current rating
    - .3 Interrupting ratings
  - .9 Cable terminal sizes
  - .10 Product Data Sheets.
- .2 The following additional information shall be submitted to the Consultant
  - .1 Busway connection
  - .2 Connection details between close-coupled assemblies
  - .3 Composite front view and plan view of close-coupled assemblies
  - .4 Interlock schematic drawing, Kirk-key or as indicated otherwise, and sequence of operations
  - .5 Mimic bus.

- .3 Submit ten copies of the above information.

#### **1.4 SUBMITTALS – FOR INFORMATION**

- .1 When requested by the Consultant, the following product information shall be submitted:
  - .1 Descriptive bulletins.
  - .2 Product guides/sheets

#### **1.5 SUBMITTALS – FOR CONSTRUCTION**

- .1 The following information shall be submitted for record purposes:
  - .1 Final as-built drawings and information for items listed in section 1.3
  - .2 Wiring diagrams
  - .3 Certified production test reports
  - .4 Installation information
- .2 The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.
- .3 Submit ten copies of the above information.

#### **1.6 QUALIFICATIONS**

- .1 The manufacturer of the assembly shall be the manufacturer of major components and control modules installed within the assembly.
- .2 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years. When requested by the Consultant, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- .3 For the equipment specified herein, the manufacturer shall be certified as a minimum to ISO 9002.

#### **1.7 REGULATORY REQUIREMENTS**

- .1 Provide a certificate of compliance with CSA 22.2 No. 178 for the transfer switches furnished under this section. The certificate of compliance is not required if the manufacturer's published data submitted and approved reflect CSA C22.2 No. 178.

## **1.8 DELIVERY, STORAGE AND HANDLING**

- .1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at the time of shipment.

## **1.9 OPERATION AND MAINTENANCE MANUALS**

- .1 Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

## **PART 2 – PRODUCTS**

### **2.1 MANUFACTURERS**

- .1 Cutler-Hammer (Eaton Electrical)
- .2 Asco Power Technologies
- .3 Russelectric Inc.
- .4 Cummins Power Corporation

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if approved by the Consultant in accordance with Section 01 61 00 – Common Product Requirements.

### **2.2 RATINGS**

- .1 The bypass isolation automatic transfer switch shall have withstand, closing and interrupting ratings sufficient for the voltage and the available short circuit at the point of application as shown on the system drawings.
- .2 The voltage rating of the transfer switch shall be no less than the system voltage rating. The continuous current rating of the transfer switch shall be no less than the maximum continuous current requirements of the system.
- .3 The bypass isolation automatic transfer switch shall be 100% equipment rated for continuous duty.

LOW VOLTAGE BYPASS / ISOLATION  
AUTOMATIC TRANSFER SWITCHES

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- .4 The bypass isolation automatic transfer switch shall be fully rated to protect all types of loads, inductive and resistive, from loss of continuity or power, without de-rating, either open or enclosed.
- .5 All control devices (i.e. pilot devices, relays, and metering) must be manufactured to industrial standards. All relays supplied shall be furnished with self-cleaning contacts.

### **2.3 TRANSFER SWITCH**

- .1 Transfer switches shall consist of completely enclosed contactors assemblies and a separate control panel. The contactors assemblies shall be operated by a stored energy mechanism and will only be energized during a transfer operation, providing inherently double throw switching action (breaker type transfer switch not acceptable).
- .2 Each transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources during automatic or manual operation. Each transfer switch shall be capable of achieving a neutral position for systems maintenance purposes. A transfer switch position indicator shall be included on the face of the transfer mechanism to display the switch position.
- .3 Transfer switches shall be capable of being operated manually under full rated load conditions. Manual operation shall provide true quick-make, quick-break operation to prevent possible flashovers from switching the contacts slowly.
- .4 On transfer switches requiring a fourth pole for switching the neutral, the neutral shall be fully rated with equal withstand, closing and interrupting ratings to the power poles. The neutral pole contacts shall be of identical construction as, and operate simultaneously with, the main power contacts. Switched neutral poles, which are add-on or overlap or that are not capable of breaking full rated load current are not acceptable.
- .5 Main contacts shall be designed to withstand multiple fault currents and shall meet the requirements of CSA 22.2 No. 178 and C22.2 No. 5.

### **2.4 BYPASS ISOLATION SWITCH**

- .1 Single-sided (one-way) bypass-isolation switches shall provide manual bypass of the load to the emergency source, and permit isolation of the automatic transfer switch from all source and load conductors. All main contacts shall be manually driven and operated.

LOW VOLTAGE BYPASS / ISOLATION  
AUTOMATIC TRANSFER SWITCHES

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- .2 Separate bypass and isolation handles shall be utilized to provide clear distinctions between these functions. All operators shall be permanently affixed and operable without opening the enclosure door (EEMAC1 only).
- .3 For bypass operation, a single-throw isolating handle mechanism shall be operated to isolate the automatic transfer switch from the normal, emergency, and load power conductors. Bypass switches will only be permitted to operate when the isolating mechanism is in the isolation position. Emergency and normal bypass switches shall be interlocked via a mechanical interlocking plate.
- .4 Field installation of power connections shall be at the line and load terminals of the bypass isolation switch. All power interconnections shall be silver-flashed or tin-plated copper bus. All control inter-wiring shall be provided with disconnect plugs.

## **2.5 MICROPROCESSOR LOGIC CONTROL**

- .1 The transfer switch shall be controlled by a Cutler-Hammer by Eaton Corporation microprocessor-based controller. The controller shall be hardened against potential problems from transients and surges. Operation of the transfer switch and monitoring of both sources shall be managed by the controller.
- .2 The logic control panel shall control the operation of the transfer switch. All sensing and logic shall be controlled by an onboard microprocessor for maximum reliability, minimum maintenance, and built-in serial communications. The logic controller shall be connected to the transfer switch by and interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control panel to be disconnect from the transfer switch for routine maintenance.
- .3 Microprocessor Controller: ATC 600

## **2.6 WIRING/TERMINATIONS**

- .1 Terminal blocks shall conform to NEMA ICS 4. Terminal blocks for remote connections shall be arranged to facilitate the entrance of external conductors from the top or bottom of the enclosure. The main transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

## **2.7 ENCLOSURE**

- .1 Each transfer switch shall have an EEMAC 1 general purpose enclosure unless otherwise noted in the Contract Documents.

## **2.8 FINISH**

- .1 The enclosure shall be painted with the manufacturer's standard painting procedures to ensure suitability for environmental conditions as referenced in the Drawings. EEMAC 1, 12, 3R and 4 enclosures shall be painted with the manufacturer's standard ASA 61 gray paint.

## **2.9 TRANSFER SWITCH OPERATION**

- .1 The following voltage and frequency sensing shall be supplied:
  - .1 The voltage of each phase of the normal source shall be monitored, with dropout adjustable from 50% to 90% of nominal and pickup adjustable from dropout setting +2% to 100% of nominal
  - .2 The voltage of each phase of the emergency source shall be monitored, with dropout adjustable from 50% to 90% of nominal and pickup adjustable from dropout setting +2% to 100% of nominal
  - .3 The frequency of the emergency source shall be monitored, with dropout adjustable from 90% to 100% of nominal and pickup adjustable from dropout setting +1 Hz to 110% of nominal.
  - .4 Voltage measurement accuracy shall be +/-2% of nominal input voltage and frequency measurement accuracy shall be +/-0.1 Hz.
- .2 The following time delay features shall be supplied:
  - .1 A time delay shall be provided to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.
  - .2 A time delay shall be provided on transfer to emergency, adjustable from 0 to 30 minutes.
  - .3 A time delay shall be provided on retransfer from emergency to normal, adjustable from 0 to 30 minutes. This time delay shall be bypassed if emergency source fails and normal source is available.
  - .4 A time delay shall be provided after retransfer that allows the generator to run unloaded prior to shutdown, adjustable from 0 to 30 minutes.
  - .5 All delays shall be field adjustable from the microprocessor-based controller without the use of special tools.

## **2.10 ACCESSORIES**

- .1 Selectable 3-phase( $\phi$ ) or 1-phase( $\phi$ ) failure protection on normal supply.
- .2 Selectable 3-phase( $\phi$ ) or 1-phase( $\phi$ ) failure protection on emergency supply.
- .3 Pilot light indication of transfer switch position and availability of normal emergency voltage sources.
- .4 Transfer switch position indicator

- .5 A momentary test selector switch or pushbutton shall be provided to simulate normal source failure.
- .6 Engine start contacts.
- .7 Transfer motor disconnect intended for manual operation.

## **2.11 OPTIONAL ACCESSORIES**

- .1 Auxiliary relay contacts shall be provided that are energized when power is available on the normal source.
- .2 Load Sequencing: Transfer switch logic shall allow the ability to perform load sequencing of 0-10 devices.

## **PART 3 – EXECUTION**

### **3.1 FACTORY TESTING**

- .1 The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of CSA and EEMAC standards.
  - .1 Insulation check to ensure the integrity of insulation and continuity of the entire system
  - .2 Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards
  - .3 Mechanical tests to verify that the switch's power sections are free of mechanical hindrances
  - .4 Electrical tests to verify the complete electrical operation of the switch and to set up time delays and voltage sensing settings of the logic
- .2 The manufacturer shall provide three certified copies of factory test reports.

### **3.2 INSTALLATION**

- .1 The Contractor shall install all equipment in accordance with the manufacturer's recommendations and the Contract Drawings.
- .2 All necessary hardware to secure the assembly in place shall be provided by the Contractor.
- .3 The equipment shall be installed and checked in accordance with the manufacturer's recommendations.



LOW VOLTAGE BYPASS / ISOLATION  
AUTOMATIC TRANSFER SWITCHES

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**3.3 FIELD QUALITY CONTROL**

- .1 Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section for a period of two Working Days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- .2 The Contractor shall provide three copies of the manufacturer's field start-up.

**3.4 MANUFACTURER'S CERTIFICATION**

- .1 A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- .2 The Contractor shall provide three copies of the manufacturer's representative's certification documentation.

**3.5 TRAINING**

- .1 The Contractor shall provide a training session for up to five Owner's representatives for one Working Day at a location determined by the Owner.
- .2 The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, and major components within the assembly.

**3.6 FIELD SERVICE ORGANIZATION**

- .1 The manufacturer of the Automatic Transfer Switch (ATS) shall also have a national service organization that is available throughout the Canada and is available on a call 24 hours a day, 365 days a year.

END OF SECTION

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LIGHTING EQUIPMENT

---

CONTENTS

SUBSECTION

TITLE

PART 1 – GENERAL

- |     |            |
|-----|------------|
| 1.1 | Summary    |
| 1.2 | References |
| 1.3 | Submittals |

PART 2 - PRODUCTS

- |     |                          |
|-----|--------------------------|
| 2.1 | Drivers for LED Fixtures |
| 2.2 | LED Fixtures             |
| 2.3 | Lighting Fixtures        |

PART 3 - EXECUTION

- |     |              |
|-----|--------------|
| 3.1 | Installation |
|-----|--------------|

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LIGHTING EQUIPMENT

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**PART 1 - GENERAL**

**1.1 SUMMARY**

- .1 This Specification Section is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with the General Conditions, Supplementary Conditions, and section 26 01 00 – Electrical General Requirements.
- .3 Provide all lighting fixtures with lamps, ballasts and accessories as specified herein and as shown on the Electrical Drawings.

**1.2 REFERENCES**

- .1 Comply with all requirements of the latest edition of CSA Standards.

**1.3 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 26 01 00 – Electrical General Requirements.
- .2 Include fixture catalogue data sheets with shop drawings. Arrange the fixture catalogue data sheets and identify in the same sequence as the specified fixture list. Fixture catalogue data sheets shall indicate the following:
  - .1 Dimensions, weight, material, finish and mounting details.
  - .2 Performance: Candle power distribution curves in two planes, Coefficient of Variation chart of indoor fixtures and lumen output chart of outdoor fixtures and flood lights.
  - .3 Pole wind loading, weight, dimension, anchoring details and finish.
  - .4 Lamps: type and base, burning hours, Colour Rendering Index, CCT and lumens.
  - .5 Ballasts: type, wiring diagram, watts, voltage, Power Factor, sound rating, starting temperature, efficiency and other required characteristics.
- .3 Submit photometric IES (Illuminating Engineering Society) file for all substituted fixtures. Where requested, submit electronic lighting level calculation analysis for the area with substituted fixtures.
- .4 Where requested, submit fixture samples of each substituted fixtures.
- .5 Where requested, submit colour chips 75 mm x 75 mm in size, or colour chart, illustrating all fixtures finish for review.
- .6 Where requested, submit certified heat-run test data for each type of ballast mounting.
- .7 Within four weeks of Contract award, provide information on electronic ballast operating frequency for Owner's co-ordination with Owner supplied equipment operating at high frequencies.

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LIGHTING EQUIPMENT

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**PART 2 - PRODUCTS**

**2.1 DRIVERS FOR LED FIXTURES**

- .1 Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated in the Contract Documents:
  - .1 Rated for 50,000 hours of life.
  - .2 Sound Rating: Class A
  - .3 Total Harmonic Distortion Rating: 20 percent or less.
  - .4 Suitable for pool application.
  - .5 5 year warranty on the whole fixture including all components, minimum.
  - .6 Approved Manufacturer: Philips Advance or approved equivalent.

**2.2 LED FIXTURES**

- .1 Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules. Refer to Drawing E100.
- .2 Include the following features unless otherwise indicated:
  - 1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply). Minimum of two drivers for two step dimming (50% and 100%) luminaires.
  - 2. Luminaire optics shall consist of precision formed optical assembly with positively retained high grade high transmittance translucent polycarbonate lens.
  - 3. Each luminaire shall be rated for a minimum operational life of 50,000 hours utilizing a minimum ambient temperature of (25°C).
  - 4. Complies with LM-80 Standards.
  - 5. Color Rendering Index (CRI) of 80 at a minimum.
  - 6. Color temperature 4000K, unless otherwise indicated.
  - 7. Fixture efficacy of 111 Lumens/Watt, minimum
  - 8. Fixture depth shall be no greater than 7"
  - 9. 5 year luminaire warranty, minimum.
  - 10. Photometry must comply with IESNA LM-79.
  - 11. Luminaires shall be Design Lights Consortium Qualified wherever applicable (depends on fixture type being used and application, doesn't apply to potlights – Energy Star rating is more appropriate for these).
  - 12. The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
  - 13. Luminaire shall be constructed such that driver may be replaced or repaired without the replacement of the whole fixture.
  - 14. Luminaires shall be UL 1598 and UL 2043 listed.
  - 15. Luminaires shall have natatorium finish, gasketed, sealed and suitable for pool application.

## LIGHTING EQUIPMENT

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### .3 Technical Requirements

1. The luminaire shall not consume power in the off state.
2. Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC/XX. The fluctuations of line voltage shall have no visible effect on the luminous output.
3. Power Factor: The luminaire shall have a power factor of 0.9 or greater.
4. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
5. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

### .4 Thermal Management

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
2. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
3. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature

### .5 Fixture Schedule, See Drawings for Lighting Fixtures Schedule.

## 2.3 LIGHTING FIXTURES

- .1 Fixtures shall have CSA labels and shall be complete with lamps, ballasts and necessary accessories for installation.
- .2 Unless otherwise indicated in the Contract Documents, troffer lighting fixture bodies to be minimum 20 gauge, cold rolled prime steel of rigid construction with knockout as required. Fixture rigidity to permit any suspension method without sag. Light fixtures to be suitable for either individual or continuous mounting. Fixture sockets to apply continuous holding pressure on lamps.
- .3 Interior fixtures shall be finished in baked white enamel (or other colour if specified) which shall resist chipping, corrosion and discolouration. Before finishing all metal to be chemically degreased and neutralized. Finish shall be a minimum of two coats of enamel, sprayed on and baked. Reflecting surfaces shall be white with an average reflectance of not less than 85%.
- .4 All fixture types designed with adequate heat sinks to dissipate the generated heat in order to prevent ballast and lamps from overheating with the resulting decrease in their rated life expectancy and/or light output. Fixtures shall be wired with type GTF fixture wire.
- .5 All fixtures shall be complete with required safety disconnect means.

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**LIGHTING EQUIPMENT**

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- .6 Fixtures to be designed so that minimum time is required for lamp or ballast replacement.
- .7 Plastic lenses to be 100% virgin acrylic a minimum of 3 mm thick.
- .8 Include all necessary accessories in tender price for a complete installation. No extra will be allowed for the supplier or contractor failing to provide such accessories.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- .1 Install all fixtures in the standard manner for the type of fixture and in accordance with the manufacturer's instructions. Support all fixtures from structural members except that fixtures installed in suspended ceilings may be supported by the ceiling where the ceiling supports are reinforced to carry the weight of the fixtures. Coordinate with the work of Division 9 and submit written confirmation to the requirements of the Ontario Building Code.
- .2 In non-accessible ceilings wire with not less than 1220 mm AC90 or RW90 wire in flexible conduit to adjacent outlet boxes placed above finished ceiling within reach of the fixture openings.
- .3 In accessible ceilings wire with 1830 mm AC90 or RW90 wire in flexible conduit to adjacent outlet boxes.
- .4 Where fixtures are not installed in approved ceiling system, provide steel fixture studs, brackets and hangers. Where fixtures are hung on chain hangers, provide chain of closed link type capable of supporting ten times the fixture weight. Use U-bolts for chain ends; S-hooks are not acceptable.
- .5 Provide suitable trim for all fixtures installed in drywall ceiling or within lay in or snap in tiles.
- .6 Provide I.C. (Insulated Ceiling) frame/enclosure for all fixtures installed in insulated ceiling. Confirm the insulated ceiling areas with Architect. Provide fire rated boxes for all recessed fixture in fire rated ceiling area.
- .7 Provide plaster frames for all fixtures recessed in plaster ceilings. Plaster frames to be installed under Division 9; and ensure that they are located correctly. The costs associated with the installation of plaster frames shall be included in the Contract Price. Protect fixtures from dirt and damage during construction and clean upon the completion of the installation. Replace fixtures showing marks or scratches due to handling or tool marks.
- .8 Protect fixtures from dirt and damage during construction and clean upon the completion of the installation. Replace fixtures showing marks or scratches due to handling or tool marks.
- .9 Align fixtures shown in continuous rows or broken lines so that all rows appear as straight lines. Crooked lines and misplaced fixtures will not be accepted.

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LIGHTING EQUIPMENT

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- .10 Where luminaries are surface mounted on inverted T-bar ceilings, they shall be supported directly from the building structure. Where this is not possible due to presence of mechanical ducts or other obstruction, supply and install galvanized steel channel, Unistrut or equal, above the ceiling, securely attached to the structure and not from the suspension system for the ceiling, and fasten the luminaires to the channel with clamping nut, bolt, flat washers and lock washer to the satisfaction of the Consultant. Provide bolts at least every 1.2m length of fixture (i.e., 3 bolts for 2.4m fixture).
- .11 Fixtures are shown on the electrical drawings in approximate locations only. Install fixtures in accordance with reflected ceiling plans, details and/or field instructions issued by the Consultant.
- .12 Install lighting fixtures in service areas, underground parking areas, unfinished areas, mechanical and electrical rooms after the mechanical and electrical equipment is in place. Locate fixtures on site to clear all obstructions to the approval of the Consultant. Provide auxiliary steel members for hanging fixtures below ducts and other equipment. Where ceiling height is more than 3 metres, suspend ceiling surface mounted fixtures at 3 metres above finished floor. Where ceiling height is more than 3 metres, suspend ceiling surface mounted fixtures at 3 metres above finished floor.
- .13 Provide all mounting hardware for all fixtures.
- .14 Check the latest ceiling finishes in all areas where recessed fixtures are specified to ensure that fixtures are purchased with suitable ceiling trim for the particular ceiling finish. Replace fixtures which are sent to the Site with wrong ceiling trim or flanges with fixtures having the correct trims, flanges, etc. as required without additional cost to the Region.
- .15 Provide safety chains for all suspended light fixtures. Attach chain to fixture and building structure. Safety chain to be designed and secured so as to sustain the sudden weight of the fixture.
- .16 In stairs, provide fixture on every main and half landing level. Co-ordinate with architectural drawings for number of landings.
- .17 Fixtures shall be installed in accordance with the reflected ceiling layouts with due consideration for mechanical diffusers, bulkheads, sprinkler heads, and other obstructions. Check mechanical and architectural drawings before roughing-in to avoid any possible conflict.
- .18 Fixtures connected to ground fault interruptor circuits shall have separate neutrals (common neutrals for 2 or 3 circuits are not acceptable).
- .19 Exterior wall mounted lighting fixtures shall be mounted on recessed boxes except where fixtures with integral outlet boxes are specified in which case the recessed outlet box is not required. Outlet boxes shall be firmly anchored to the wall.

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**LIGHTING EQUIPMENT**

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- .20 Unless otherwise indicated in the Contract Documents, supply and install concrete bases for lighting standards. Concrete bases shall be trowel finished with all exposed corners bevelled at 45 degrees. Junction boxes shall be carefully set and anchored to ensure flush fit of junction box cover. Concrete bases shall be constructed of 20 Mpa concrete air entrained and steel reinforced as shown on the Drawings.

**END OF SECTION**



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EMERGENCY LIGHTING SYSTEM

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
-------------------	--------------

PART 1 – GENERAL

1.1	Summary
1.2	Reference
1.3	Submittals
1.4	Warranty
1.5	Manufacturers

PART 2 - PRODUCTS

2.1	Standard Exit Signs
2.2	Weatherproof-Exit Signs
2.3	Standard Remote Heads
2.4	Weatherproof and Vandal Resistant Remote Heads
2.5	Battery Unit
2.6	Wiring

PART 3 - EXECUTION

3.1	Installation
3.2	Testing and Verification

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EMERGENCY LIGHTING SYSTEM

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**PART 1 - GENERAL**

**1.1 SUMMARY**

- .1 This Specification Section is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with General Conditions, Supplementary Conditions, and Section 26 01 00 – Electrical General Requirements.
- .3 Provide emergency lighting system including exit signs, remote heads, and battery units, as shown on the drawings, as specified herein and as otherwise required.

**1.2 REFERENCE**

- .1 Comply with the requirements of the latest edition of the following:
  - .1 CSA-C22.2 No. 9, General Requirements for Luminaires.
  - .2 CSA-C22.2 No. 141, Unit Equipment for Emergency Lighting.
  - .3 CSA-C22.2 C860, Performance of Internally Lighting Exit Signs.
  - .4 CSA-C282, Emergency Electrical Power Supply for Buildings.

**1.3 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 26 01 00 – Electrical General Requirements.
- .2 Include fixture catalogue data sheets with shop drawings indicating dimensions, components, electrical characteristics and performance data for each fixture and device. Arrange the fixture catalogue data sheets and identify in the same sequence as the specified Subsection 2.1 to 2.5 of this Section
- .3 Submit test report and verifications following the completion of testing.

**1.4 WARRANTY**

- .1 For complete system, provide a 2-year no-charge, unconditional guarantee, and 5-year pro-rate charge guarantee on workmanship and parts.
- .2 For batteries, on the second 5-year, provide a pro-rate charge guarantee on workmanship and parts.

**1.5 MANUFACTURERS**

- .1 Acceptable manufacturers:
  - .1 Emergi-Lite(Thomas & Betts)
  - .2 Beghelli Canada
  - .3 Lumacell (Thomas & Betts).

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EMERGENCY LIGHTING SYSTEM

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**PART 2 - PRODUCTS**

**2.1 STANDARD EXIT SIGNS**

- .1 Plates and housing: green 'running-man' pictogram on white background.
- .2 Lamps: Less than 2W, LED.
- .3 Inputs:
  - .1 DC: 24V as shown.
  - .2 AC: Universal: 120V/347V.
- .4 Directional arrows: universal type for field adjustment.
- .5 Mounting: universal for field selection.
- .6 Provide white metal wire guard as indicated on the Drawings.

**2.2 WEATHER-PROOF EXIT SIGNS**

- .1 Same as standard exit signs, except:
  - .1 Housing to be industrial grade polyvinyl chloride fully gasketted around lens and canopy.
  - .2 The sealed face plate shall be constructed of heavy duty vandal-resistant polycarbonate.

**2.3 STANDARD REMOTE HEADS**

- .1 Single or double cast aluminum head(s), complete with mounting plates, 300 degree horizontal and 80 degree vertical minimum adjustment.
- .2 Lamps: MR16 Narrow beam, 20W or as shown.
- .3 Input: 24VDC as shown.
- .4 Mounting: ceiling or wall as shown.
- .5 Finish: white painted.
- .6 Provide white metal wire guard as indicated on the Drawings.

**2.4 WEATHERPROOF AND VANDAL RESISTANT REMOTE HEADS**

- .1 Same as standard remote heads, except fully gasketted cast aluminum back plate with clear polycarbonate vandal resistant cover.

**2.5 BATTERY UNIT**

- .1 Supply voltage: as indicated on the Electrical Drawings.
- .2 Output voltage: 24V DC.
- .3 Operating time: 1/2 hour minimum.

### **EMERGENCY LIGHTING SYSTEM**

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- .4 Battery: sealed, maintenance free, long-time lead with rated life of 10 years.
- .5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations capable of restoring a discharged battery to the fully-charged state within 24 hours, and switched to a float charge when not in full charge mode.
- .6 Solid state transfer circuit.
- .7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .8 Signal lights: solid state, for "AC Power ON" and "High Charge".
- .9 Lamp heads: integral on unit and remote, 345° horizontal and 180° vertical adjustment, white painted cast aluminum head. Lamp type: wide beam flat MR16, 2-20W, unless noted otherwise.
- .10 Cabinet: suitable for direct or shelf mounting to wall and complete with knockouts for conduits. Removable or hinged front panel for easy access to batteries.
- .11 Finish: standard factory finish.
- .12 Auxiliary equipment:
  - .1 Advanced diagnostic printed circuit board with auto self test and time delay.
  - .2 Test switch and LED trouble indicator.
  - .3 Battery disconnect device.
  - .4 AC input and dc output terminal blocks inside cabinet.
  - .5 Mounting shelf.
  - .6 Transient voltage surge suppressor on the supply side of power to the unit.

## **2.6 WIRING**

- .1 Refer to Section 26 05 00 – Basic Materials and Methods, Subsection 2.1 - Wires and Cables.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- .1 Pendant mount exit sign in service rooms and other areas where necessary to clear obstructions. Install suspended exit signs using pendants supported from swivel hangers.
- .2 Install all unit equipment, remote heads, exit signs, and accessories in accordance with the manufacturer's instruction.

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**EMERGENCY LIGHTING SYSTEM**

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- .3 Direct heads for illumination to meet OBC requirements.

**3.2 TESTING AND VERIFICATION**

- .1 Arrange with the manufacturer to conduct a complete inspection and test of all installed emergency lighting system.
- .2 Ensure that the manufacturer's representative performs the following items: properly aiming remote heads, recording the light level readings, recording battery full load operation time, issuing a verification indicating that lighting levels meet OBC requirements, and the system has been installed properly.
- .3 Submit report and verification to the Consultant.
- .4 Correct all deficiencies.
- .5 Witnessed by Authority having Jurisdiction and Consultant.
- .6 All costs associated with testing, verification, and corrections shall be included in the Contract Price.

**END OF SECTION**

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LIGHTING CONTROL SYSTEM

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CONTENTS

<u>SUBSECTION</u>	<u>TITLE</u>
-------------------	--------------

PART 1 – GENERAL

1.1	Summary
1.2	Reference
1.3	Submittals
1.4	Warranty
1.5	Manufacturers

PART 2 - PRODUCTS

2.1	Standard Exit Signs
2.2	Weatherproof-Exit Signs
2.3	Standard Remote Heads
2.4	Weatherproof and Vandal Resistant Remote Heads
2.5	Battery Unit
2.6	Wiring

PART 3 - EXECUTION

3.1	Installation
-----	--------------

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LIGHTING CONTROL SYSTEM

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**PART 1 - GENERAL**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Digital Lighting Controls
  - .2 Relay Panels
  - .3 Emergency Lighting Control (if applicable)
- .2 Related Sections:
  - .1 Section 261400 - Wiring Devices:
  - .2 Section 265000 – Lighting Equipment.
  - .3 Section [259500 – Building Automation System] Building integrator shall provide integration of the lighting control system with Building Automation Systems.
  - .4 Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section
  - .5 Electrical Sections, including wiring devices, apply to the work of this Section.
- .3 Control Intent – Control Intent includes, but is not limited to:
  - .1 Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
  - .2 Initial sensor and switching zones
  - .3 Initial time switch settings
  - .4 Task lighting and receptacle controls
  - .5 Emergency Lighting control (if applicable)

**1.2 REFERENCES**

- .1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
- .2 Underwriter Laboratories of Canada (ULC)
- .3 International Electrotechnical Commission (IEC)
- .4 International Organization for Standardization (ISO)
- .5 National Electrical Manufacturers Association (NEMA)
- .6 WD1 (R2005) - General Color Requirements for Wiring Devices.
- .7 Underwriters Laboratories, Inc. (UL)
  - 1. 20 – Plug Load Controls
  - 2. 508– Industrial Controls

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LIGHTING CONTROL SYSTEM

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3. 916 – Energy Management Equipment.
4. 924 – Emergency Lighting

### 1.3 SYSTEM DESCRIPTION & OPERATION

- .1 The Lighting Control and Automation system as defined under this section covers the following equipment:
  - .1 Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
  - .2 Digital Switches – Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
  - .3 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.
  - .4 Digital Daylighting Sensors – Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications can provide switching, bi-level, tri-level or dimming control for daylight harvesting.
  - .5 Digital Room Controllers – Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
  - .6 Digital Plug-Load Controllers – Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities.
  - .7 Configuration Tools – Handheld remote for room configuration and relay panel programming 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 bi-directional communication of room variables and occupancy sensor settings. Computer software also customizes room settings.
  - .8 Digital Lighting Management (DLM) local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
  - .9 Digital Lighting Management (DLM) segment network – Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded,) to connect multiple DLM local networks for centralized control
  - .10 Network Bridge – provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.



#### LIGHTING CONTROL SYSTEM

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- .11 Segment Manager – provides web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
- .12 Programming and Configuration software – Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
- .13 LMCP Digital Lighting Management Relay Panel – provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS).
- .14 Emergency Lighting Control Unit (ELCU) – allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

#### 1.4 LIGHTING CONTROL APPLICATIONS

- .1 Unless relevant provisions of the applicable local Energy Codes are more stringent, provide a minimum application of lighting controls as follows:
  - .1 Space Control Requirements – Provide occupancy/vacancy sensors with Manual- or Partial-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 Task Lighting / Plug Loads – Provide automatic shut off of non essential plug loads and task lighting in all spaces except toilet rooms and storerooms. Provide Automatic-ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
  - .4 Daylit Areas – Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
    - .1 All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.

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**LIGHTING CONTROL SYSTEM**

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- .2 Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
- .3 Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings.
- .4 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.
- .5 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. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

**1.5 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.
  - .2 Show exact location of all digital devices, including at minimum sensors, room controllers, and switches for each area on reflected ceiling plans. (Contractor must provide AutoCAD format reflected ceiling plans.)
  - .3 Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
  - .4 Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.
- .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.

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**LIGHTING CONTROL SYSTEM**

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**1.6 QUALITY ASSURANCE**

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

**1.7 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.

**1.8 WARRANTY**

- .1 Provide a five year limited manufacturer's warranty on all room control devices and panels.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- .1 Acceptable Manufacturer:
  - .1 WattStopper
    - .1 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:
    - .1 Douglas Lighting Control
    - .2 SensorSwitch
    - .3 Approved Alternate

**2.2 DIGITAL LIGHTING CONTROLS**

- .1 Furnish the Company's system which accommodates the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories which suit the lighting and electrical system parameters.

**2.3 DIGITAL WALL SWITCH OCCUPANCY SENSORS**

- .1 Wallbox mounted passive infrared PIR or dual technology (passive infrared and ultrasonic) digital occupancy sensor with 1 or 2 switch buttons.

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LIGHTING CONTROL SYSTEM

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- .2 Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
  - .1 Digital calibration and pushbutton configuration for the following variables:
    - .1 Sensitivity – 0-100% in 10% increments
    - .2 Time delay – 1-30 minutes in 1 minute increments
    - .3 Test mode – Five second time delay
    - .4 Detection technology – PIR, Dual Technology activation and/or re-activation.
    - .5 Walk-through mode
    - .6 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
  - .2 Programmable control functionality including:
    - .1 Each sensor may be programmed to control specific loads within a local network.
    - .2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.
    - .3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
    - .4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
      - .1 Ultrasonic and Passive Infrared
      - .2 Ultrasonic or Passive Infrared
      - .3 Ultrasonic only
      - .4 Passive Infrared only
  - .3 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
  - .4 Two RJ-45 ports for connection to DLM local network.
  - .5 Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.
  - .6 Device Status LEDs including:
    - .1 PIR detection
    - .2 Ultrasonic detection
    - .3 Configuration mode
    - .4 Load binding
  - .7 Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
  - .8 Assignment of local buttons to specific loads within the room without wiring or special tools
  - .9 Manual override of controlled loads.

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LIGHTING CONTROL SYSTEM

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- .10 All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.
- .3 BACnet object information shall be available for the following objects:
  - .1 Detection state
  - .2 Occupancy sensor time delay
  - .3 Occupancy sensor sensitivity, PIR and Ultrasonic
  - .4 Button state
  - .5 Switch lock control
  - .6 Switch lock status
- .4 Units shall not have any dip switches or potentiometers for field settings.
- .5 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.
- .6 Two-button wall switch occupancy sensors, when connected to a single relay dimming room controller, shall operate in the following sequence as a factory default:
  - .1 Left button
    - .1 Press and release - Turn load on
    - .2 Press and hold - Raise dimming load
  - .2 Right button
    - .1 Press and release - Turn load off
    - .2 Press and hold - Lower dimming load
- .7 Low voltage momentary pushbuttons shall include the following features:
  - .1 Load/Scene Status LED on each switch button with the following characteristics:
    - .1 Bi-level LED
    - .2 Dim locator level indicates power to switch
    - .3 Bright status level indicates that load or scene is active
  - .2 The following button 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.

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LIGHTING CONTROL SYSTEM

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- .6 Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.
- .8 WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

**2.4 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR**

- .1 Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
- .2 Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
  - .1 Digital calibration and pushbutton configuration for the following variables:
    - .1 Sensitivity – 0-100% in 10% increments
    - .2 Time delay – 1-30 minutes in 1 minute increments
    - .3 Test mode – Five second time delay
    - .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
    - .5 Walk-through mode
    - .6 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
  - .2 Programmable control functionality including:
    - .1 Each sensor may be programmed to control specific loads within a local network.
    - .2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.
    - .3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
    - .4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
      - .1 Ultrasonic and Passive Infrared
      - .2 Ultrasonic or Passive Infrared
      - .3 Ultrasonic only
      - .4 Passive Infrared only
  - .3 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
  - .4 One or two RJ-45 port(s) for connection to DLM local network.
  - .5 Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

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#### LIGHTING CONTROL SYSTEM

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- .6 Device Status LEDs, which may be disabled for selected applications, including:
  - .1 PIR detection
  - .2 Ultrasonic detection
  - .3 Configuration mode
  - .4 Load binding
- .7 Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
- .8 Manual override of controlled loads.
- .9 All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- .3 BACnet object information shall be available for the following objects:
  - .1 Detection state
  - .2 Occupancy sensor time delay
  - .3 Occupancy sensor sensitivity, PIR and Ultrasonic
- .4 Units shall not have any dip switches or potentiometers for field settings.
- .5 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.
- .6 WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

### 2.5 DIGITAL WALL SWITCHES

- .1 Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. 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 Configuration LED on each switch that blinks to indicate data transmission.
  - .4 Load/Scene Status LED on each switch button with the following characteristics:
    - .1 Bi-level LED
    - .2 Dim locator level indicates power to switch
    - .3 Bright status level indicates that load or scene is active
  - .5 Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

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LIGHTING CONTROL SYSTEM

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- .6 Programmable control functionality including:
  - .1 Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
  - .2 Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
- .7 All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- .2 BACnet object information shall be available for the following objects:
  - .1 Button state
  - .2 Switch lock control
  - .3 Switch lock status
- .3 Two RJ-45 ports for connection to DLM local network.
- .4 Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- .5 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.
- .6 WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.



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LIGHTING CONTROL SYSTEM

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## **2.6 HANDHELD REMOTE CONTROLS**

- .1 Battery-operated handheld devices 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 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.

## **2.7 DIGITAL PARTITION CONTROLS**

- .1 Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.
- .2 Four-button low voltage pushbutton switch for manual control.
  - .1 Two-way infrared (IR) transceiver for use with configuration remote control.
  - .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 Configuration LED on each switch that blinks to indicate data transmission.
  - .4 Each button represents one wall; Green button LED indicates status.
  - .5 Two RJ-45 ports for connection to DLM local network.
  - .6 WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening.
- .3 Contact closure interface for automatic control via input from limit switches on movable walls (by others).
  - .1 Operates on Class 2 power supplied by DLM local network.
  - .2 Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
    - .1 Input max. sink/source current: 1-5mA
    - .2 Logic input signal voltage High: >18VDC
    - .3 Logic input signal voltage Low: <2VDC

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LIGHTING CONTROL SYSTEM

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- .3 Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
- .4 Two RJ-45 ports for connection to DLM local network.
- .5 WattStopper part number: LMIO-102

## 2.8 DIGITAL DAYLIGHTING SENSORS

- .1 Digital daylighting sensors shall work with room controllers to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to a room controller. Daylighting sensors shall be interchangeable without the need for rewiring.
  - .1 Closed loop sensors measure the ambient light in the space and control a single lighting zone.
  - .2 Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
  - .3 Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone.
- .2 Digital daylighting sensors shall include the following features:
  - .1 The sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire 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.
  - .2 Sensor light level range shall be from 1-6,553 footcandles (fc).
  - .3 The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
  - .4 For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
  - .5 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 field-selectable minimum level.
  - .6 Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
  - .7 Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.

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LIGHTING CONTROL SYSTEM

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- .8 Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
- .9 Integral 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.
- .10 Configuration LED status light on device that blinks to indicate data transmission.
- .11 Status LED indicates test mode, override mode and load binding.
- .12 Recessed switch on device to turn controlled load(s) ON and OFF.
- .13 BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
  - .1 Light level
  - .2 Day and night setpoints
  - .3 Off time delay
  - .4 On and off setpoints
  - .5 Up to three zone setpoints
  - .6 Operating mode – on/off, bi-level, tri-level or dimming
- .14 One RJ-45 port for connection to DLM local network.
- .15 A choice of accessories to accommodate multiple mounting methods and building materials. The photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62" thickness (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62"-1.25" thickness (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.
- .16 Any load or group of loads in the room can be assigned to a daylighting zone
- .17 Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
- .18 All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.
- .3 Closed loop digital photosensors shall 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.

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LIGHTING CONTROL SYSTEM

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- .3 Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.
- .4 WattStopper Product Number: LMLS-400, LMLS-400-L.
- .4 Open loop digital photosensors shall 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 application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
  - .3 Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
  - .4 WattStopper Product Number: LMLS-500, LMLS-500-L.
- .5 Dual loop digital photosensors shall include the following additional features:
  - .1 Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this con
  - .2 Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.
  - .3 Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.
  - .4 Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.
  - .5 Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.
  - .6 Device must include extendable mounting arm to properly position sensor within a skylight well.
  - .7 WattStopper product number LMLS-600

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LIGHTING CONTROL SYSTEM

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**2.9 DIGITAL ROOM CONTROLLERS AND PLUG-LOAD CONTROLLERS**

- .1 Digital controllers for lighting and plug loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room and plug load controllers shall be provided to match the room lighting and plug load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard Plug n' Go applications. 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.
  - .3 Multiple room controllers connected together in a local network must automatically prioritize each room controller, without requiring any configuration or setup, so that loads are sequentially assigned using room controller device ID's from highest to lowest.
  - .4 Device Status LEDs to indicate:
    - .1 Data transmission
    - .2 Device has power
    - .3 Status for each load
    - .4 Configuration status
  - .5 Quick installation features including:
    - .1 Standard junction box mounting
    - .2 Quick low voltage connections using standard RJ-45 patch cable
  - .6 Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
    - .1 Turn on to 100%
    - .2 Remain off
    - .3 Turn on to last level
  - .7 Each load shall be configurable to operate in the following sequences based on occupancy:
    - .1 Auto-on/Auto-off (Follow on and off)
    - .2 Manual-on/Auto-off (Follow off only)
  - .8 The polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.
  - .9 BACnet object information shall be available for the following objects:
    - .1 Load status
    - .2 Electrical current
    - .3 Total watts per controller
    - .4 Schedule state – normal or after-hours
    - .5 Demand response control and cap level
    - .6 Room occupancy status
    - .7 Total room lighting and plug loads watts

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LIGHTING CONTROL SYSTEM

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- .8 Total room watts/sq ft
- .9 Force on/off all loads
- .10 UL 2043 plenum rated
- .11 Manual override and LED indication for each load
- .12 Dual voltage (120/277 VAC, 60 Hz), or 347 VAC, 60 Hz (selected models only). 120/277 volt models rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming); 347 volt models rated for 15A total load; plug load controllers carry application-specific UL 20 rating for receptacle control.
- .13 Zero cross circuitry for each load
- .14 All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- .2 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 with integral strain relief and dust cover
  - .4 WattStopper product numbers: LMRC-101, LMRC-102
- .3 On/Off/Dimming enhanced Room Controllers shall include:
  - .1 Real time current monitoring
  - .2 Multiple relay configurations
    - .1 One, two or three relays (LMRC-21x series)
    - .2 One or two relays (LMRC-22x series)
  - .3 Efficient 250 mA switching power supply
  - .4 Four RJ-45 DLM local network ports with integral strain relief and dust cover
  - .5 One dimming output per relay
    - .1 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting. (LMRC-21x series)
    - .2 Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-22x series)
    - .3 Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.

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LIGHTING CONTROL SYSTEM

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- .4 The LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
- .5 Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim.
- .6 Calibration and trim levels must be set per output channel.
- .7 Devices that set calibration or trim levels per controller are not acceptable.
- .8 All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
- .6 Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
- .7 Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
- .8 The following dimming attributes may be changed or selected using a wireless configuration tool:
  - .1 Establish preset level for each load from 0-100%
  - .2 Set high and low trim for each load
  - .3 Set lamp burn in time for each load up to 100 hours
- .9 Override button for each load provides the following functions:
  - .1 Press and release for on/off control
  - .2 Press and hold for dimming control
- .10 WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMRC-221, LMRC-222
- .4 Plug Load Room Controllers shall include:
  - .1 One relay configuration with additional connection for unswitched load
  - .2 Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
  - .3 Factory default operation is Auto-on/Auto-off, based on occupancy
  - .4 Real time current monitoring of both switched and un-switched load (LMPL-201 only)
  - .5 Efficient switching power supply
    - .1 150mA (LMPL-101)
    - .2 250mA (LMPL-201)
  - .6 RJ-45 DLM local network ports
    - .1 Three RJ-45 ports (LMPL-101)
    - .2 Four RJ-45 ports (LMPL-201)
  - .7 WattStopper product numbers: LMPL-101, LMPL-201.

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**LIGHTING CONTROL SYSTEM**

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**2.10 DLM LOCAL NETWORK (Room 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.
- .2 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.
- .3 Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
- .4 If manufacturer's pre-terminated Cat 5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.
- .5 WattStopper Product Number: LMRJ-Series

**2.11 DLM SEGMENT NETWORK (Room to Room Network)**

- .1 The segment network shall be a linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.
  - .1 Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
  - .2 Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
  - .3 The segment network shall utilize 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. The maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.



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**LIGHTING CONTROL SYSTEM**

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- .4 Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
  - .5 Substitution of manufacturer-supplied cable must be pre-approved: Manufacturer will not certify network reliability, and reserves the right to void warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
  - .6 Segment networks shall be capable of connecting to BACnet-compliant BAS (provided by others) either directly, via MS/TP, or through NB-ROUTERS, via BACnet/IP or BACnet/Ethernet. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable.
- .2 WattStopper Product Number: LM-MSTP, LM-MSTP-DB

**2.12 CONFIGURATION TOOLS**

- .1 A wireless configuration tool facilitates optional customization of DLM local networks using two-way 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 but not be limited to:
  - .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 Must be able to read and modify parameters for room controllers, occupancy sensors, wall switches, daylighting sensors, network bridges and relay panels, and identify room devices by type and serial number.
  - .4 Save up to eight 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. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
  - .6 Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
  - .7 Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
  - .8 Verify status of building level network devices.
- .3 WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

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LIGHTING CONTROL SYSTEM

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**2.13 NETWORK BRIDGE**

- .1 The network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
  - .1 The network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
  - .2 Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.
  - .3 The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. BACnet objects will be created for the addition or replacement of any given in-room DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
    - .1 Read/write the normal or after hours schedule state for the room
    - .2 Read the detection state of each occupancy sensor
    - .3 Read the aggregate occupancy state of the room
    - .4 Read/write the On/Off state of loads
    - .5 Read/write the dimmed light level of loads
    - .6 Read the button states of switches
    - .7 Read total current in amps, and total power in watts through the room controller
    - .8 Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
    - .9 Activate a preset scene for the room
    - .10 Read/write daylight sensor fade time and day and night setpoints
    - .11 Read the current light level, in footcandles, from interior and exterior photosensors and photocells
    - .12 Set daylight sensor operating mode
    - .13 Read/write wall switch lock status
    - .14 Read watts per square foot for the entire controlled room
    - .15 Write maximum light level per load for demand response mode
    - .16 Read/write activation of demand response mode for the room
    - .17 Activate/restore demand response mode for the room

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LIGHTING CONTROL SYSTEM

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- .2 WattStopper product numbers: LMBC-300

**2.14 SEGMENT MANAGER**

- .1 For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).
- .2 Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the plans.
- .3 Operational features of the Segment Manager shall include the following:
  - .1 Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
  - .2 Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. Shall not require installation of any lighting control software to an end-user PC.
  - .3 Log in security capable of restricting some users to view-only or other limited operations.
  - .4 Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
  - .5 After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
  - .6 Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.
  - .7 Ability to set up schedules for rooms and panels, view and override current status of panel channels and relays, and assign relays to groups. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation. Support for a minimum of 100 unique schedules, each with up to four time events per day. Support for annual schedules, holiday schedules and unique date-bound schedules.

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#### LIGHTING CONTROL SYSTEM

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- .8 Ability to group rooms and loads for common control by schedules, switches or network commands.
- .9 Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature.
- .10 Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control.
- .11 The Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.
- .4 Segment Manager shall support multiple DLM rooms as follows:
  - .1 Support up to 120 network bridges and 900 digital in-room devices (LMSM-3E).
  - .2 Support up to 300 network bridges and 2,200 digital in room devices, connected via network routers and switches (LMSM-6E).
- .5 WattStopper Product Numbers: LMSM-3E, LMSM-6E, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

#### **2.15 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE**

- .1 PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.
  - .1 Additional parameters exposed through this method include but are not limited to:
    - .1 Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.
    - .2 Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.

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LIGHTING CONTROL SYSTEM

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- .3 Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.
- .4 Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.
- .5 Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.
- .6 Load control polarity reversal so that on events turn loads off and vice versa.
- .7 Per-load DR (demand response) shed level in units of percent.
- .8 Load output pulse mode in increments of 1second.
- .9 Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.
- .2 Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:
  - .1 Device list report: All devices in a project listed by type.
  - .2 Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.
  - .3 BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.
  - .4 Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.
  - .5 Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.
  - .6 Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100%, 2 = all loads 75%, 3 = all loads 50%, 4 = all loads 25%, 5-16 = same as scene 1).
  - .7 Occupancy sensor report: Basic settings including time delay and sensitivity(ies) for all occupancy sensors.
- .3 Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:
  - .1 Set, copy/paste an entire project site of sensor time delays.
  - .2 Set, copy/paste an entire project site of sensor sensitivity settings.
  - .3 Search based on room name and text labels.
  - .4 Filter by product type (i.e. LMRC-212) to allow parameter set by product.
  - .5 Filter by parameter value to search for product with specific configurations.
- .4 Network-wide firmware upgrading remotely via the BACnet/IP network.
  - .1 Mass firmware update of entire rooms.
  - .2 Mass firmware update of specifically selected rooms or areas.

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LIGHTING CONTROL SYSTEM

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- .3 Mass firmware upgrade of specific products.
- .2 WattStopper Product Number: LMCS-100, LMCI-100

**2.16 LMCP 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:
  - .1 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.
  - .2 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.
  - .3 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:
    - .1 Removable, plug-in terminal blocks with connections for all low voltage terminations.
    - .2 Individual terminal block, override pushbutton, and LED status light for each relay.
    - .3 Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
    - .4 Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
    - .5 True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
    - .6 Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.

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LIGHTING CONTROL SYSTEM

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- .7 Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
- .8 Relay group status shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
- .9 Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
  - .1 Electrical:
    - .1 30 amp ballast at 277V
    - .2 20 amp ballast at 347V
    - .3 20amp tungsten at 120V
    - .4 30 amp resistive at 347V
    - .5 1.5 HP motor at 120V
    - .6 14,000 amp short circuit current rating (SCCR) at 347V
    - .7 Relays shall be specifically UL 20 listed for control of plug-loads
  - .2 Mechanical:
    - .1 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.
- .4 Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
- .5 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.
- .6 Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.

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LIGHTING CONTROL SYSTEM

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- .7 Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
  - .1 Each panel shall include digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
  - .2 The clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
  - .3 The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
  - .4 The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
    - .1 Scheduled ON / OFF
    - .2 Manual ON / Scheduled OFF
    - .3 Astro ON / OFF (or Photo ON / OFF)
    - .4 Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
  - .5 The user interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)
  - .6 The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
  - .7 Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
- .8 The lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.



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LIGHTING CONTROL SYSTEM

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- .9 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 MS/TP-based using the BACnet® protocol.
  - .1 The panel shall have provision for an individual BACnet device ID and shall support the full 2<sup>22</sup> range (0 – 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
  - .2 The panel shall support MS/TP MAC addresses in the range of 0 – 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
  - .3 Lighting control relays shall be controllable as binary output objects in the instance range of 1 – 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
  - .4 Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 – 64.
  - .5 The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 – 299. 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 normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
  - .6 Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
    - .1 Binary output objects in the instance range of 1 – 64 (one per relay) for on/off control of relays.
    - .2 Binary value objects in the instance range of 1 – 99 (one per channel) for normal hours/after hours schedule control.
    - .3 Binary input objects in the instance range of 1 – 64 (one per relay) for reading true on/off state of the relays.
    - .4 Analog value objects in the instance range of 101 – 199 (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 grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.

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LIGHTING CONTROL SYSTEM

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- .7 The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
  - .8 The BO and BV 1 – 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<http://www.bacnet.org/Addenda/Add-135-2010aa.pdf>)
  - .9 Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
  - .10 Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.
  - .10 WattStopper Product Number: LMCP8, LMCP24 or LMCP48
- .2 User Interface
- Each lighting control panel system shall be supplied with at least (1) handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool 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 panel-specific functions as a minimum:
- .1 Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
  - .2 Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
  - .3 Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
  - .4 Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
  - .5 Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.

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## LIGHTING CONTROL SYSTEM

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- .6 Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
- .7 An additional handheld IR remote may optionally be specified to be permanently mounted to the panel interior via a retractable anti-theft lanyard to allow for convenient programming of the panel while assuring that the handheld programmer is always present at that panel. An unlimited number of handheld IR remotes may also be purchased for facilities staff as determined by the end user's representative.
- .8 WattStopper Product Number: LMCT-100

### **2.17 EMERGENCY LIGHTING CONTROL DEVICES**

- .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.

## **PART 3 - EXECUTION**

### **3.1 PRE-INSTALLATION MEETING**

- .1 A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
  - .1 Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
  - .2 Review the specifications for low voltage control wiring and termination.
  - .3 Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
  - .4 Discuss requirements for integration with other trades.

### **3.2 CONTRACTOR INSTALLATION AND SERVICES**

- .1 Contractor to install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.

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**LIGHTING CONTROL SYSTEM**

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- .2 Contractor to install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors. If pre-terminated cable is not used for room/area wiring, the contractor is responsible for testing each field-terminated cable following installation, and shall supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty per DLM SEGMENT NETWORK section of specification. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.
- .3 Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.
- .4 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 while occupied.
- .5 Provide written or computer-generated documentation on the configuration of the system including room by room description including:
  - .1 Sensor parameters, time delays, sensitivities, and daylighting setpoints.
  - .2 Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
  - .3 Load Parameters (e.g. blink warning, etc.)
- .6 Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report to the Architect / Owner of post start-up activity.

**3.3 FACTORY SERVICES (OPTIONAL)**

- .1 Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.
- .2 The electrical contractor shall provide both the manufacturer and the Electrical Consultant with three weeks written notice of the system start up and adjustment date.
- .3 Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

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LIGHTING CONTROL SYSTEM

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**3.4 COMMISSIONING SUPPORT SERVICES**

- .1 On this project, a commissioning agent will be hired to verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the agent with this task.
- .2 The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the contract documents.

END OF SECTION

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FIRE ALARM SYSTEM

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CONTENTS

SUBSECTION

TITLE

PART 1 – GENERAL

1.1	Summary
1.2	Reference
1.3	Submittals
1.4	Qualifications

PART 2 - PRODUCTS

2.1	System Description
2.2	System Operation
2.3	Fire Alarm Control Panel
2.4	System Devices
2.5	Wiring
2.6	Special Environment

PART 3 - EXECUTION

3.1	Installation
3.2	Testing and Certification
3.3	Training

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**FIRE ALARM SYSTEM**

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**PART 1 - GENERAL**

**1.1 SUMMARY**

- .1 This Specification Section is an integral part of the Contract Documents and shall be read accordingly.
- .2 Comply with General Conditions, Supplementary Conditions, and Section 26 01 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 the 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 01 00 – Electrical General Requirements. 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 documents to the local fire department as required by the local fire department.

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## FIRE ALARM SYSTEM

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- .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 26 01 00 – Electrical General Requirements. 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 Canada
  - .2 ChubbEdwards (GE Security Corporation)
  - .3 Notifier by Honeywell
  - .4 The Mircom Group of Companies
- .2 Installer: Certified fire alarm installer with service facilities 100km of project.

## **PART 2 - PRODUCTS**

### 2.1 SYSTEM DESCRIPTION

- .1 The fire alarm system shall be an OBC, single stage, zoned non-coded, fully 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.



## FIRE ALARM SYSTEM

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- .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 FACP program will be transferred to a "secondary" configuration memory bank, while the FACP 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.

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FIRE ALARM SYSTEM

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- .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 minute of alarm, the system could be manually silenced via the silencing switch on the control panel. A subsequent alarm shall re-activate 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.

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**FIRE ALARM SYSTEM**

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**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 on Drawing E504 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 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 (Drawing E504) and to the requirements of local Ontario Building Inspector and local Fire Department
- .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 the FACP.
  - .2 Transmission of signal to off-premises central monitoring station. Third Party Monitoring Company will be hired directly by the Region.
  - .3 Signals to elevator controllers.
  - .4 Signals to maglock release and hold open devices.
  - .5 Transmission of signal to security system for fire alarm monitoring.
  - .6 Other functions as required on the Drawings.
  - .7 20% spare output points for future.

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**FIRE ALARM SYSTEM**

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- .9 Operator interface keypad. Provide LCD display with wording to the Consultant's approval in accordance with Fire Alarm Schedule on Drawing E504.
- .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 the elevator controller.

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FIRE ALARM SYSTEM

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- .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 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 FACP.
  - .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 the 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 the manufacturer's recommendations. Co-ordinate the proper location and installation with Mechanical Division 23.
  - .4 Where duct-mounted smoke detectors are installed outdoors, provide weather-proof enclosure. Provide heater and power and the 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 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.

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FIRE ALARM SYSTEM

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.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 air handling units 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:
    - .1 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.
    - .2 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
    - .1 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.
    - .2 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.

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FIRE ALARM SYSTEM

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- .3 Type 3: Single Address Multi-Point Interface Modules
  - .1 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.
  - .2 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.
  - .3 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
  - .1 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
  - .1 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.

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**FIRE ALARM SYSTEM**

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- .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 displace 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.



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**FIRE ALARM SYSTEM**

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- .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 any area that may be exposed to moisture. Devices shall be weather-proof where located outside.
- .2 Provide heater and power provision to the heater completed with the required rough-ins breaker and wiring, (circuit breaker may not be shown on the Drawings), for devices located in cold area as required by the manufacturer in order to maintain operation of such respective devices.
- .3 Where the devices located in cold 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 the Drawings.

**PART 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 local Ontario Building Inspector and/or local Fire Department. 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 conflicts with the Ontario Building Code and/or ULC 524 and/or the requirement of local Ontario Building Inspector and/or local Fire Department, bring this to the attention of the Consultant, and do not proceed with the work until the matter is clarified by the Consultant.
- .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 Mechanical Division 23.
    - .2 Provide wiring and connections to sprinkler and fire standpipe pumps equipped with supervisory contacts provided by Mechanical Division for 'Loss of Power', 'Phase Reversal' and 'Pump(s) Running' indications.

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**FIRE ALARM SYSTEM**

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- .2 Motor Control Connections
  - .1 Provide all wiring and connections from the fire alarm system to motor starters as required for shutdown and/or start-up. Co-ordinate connection and location with the work of the Mechanical Division 23 for proper system operation.
  - .2 Wiring for local fans operation on smoke condition shall be installed by Electrical Division 26 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 the equipment of other Divisions 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 Ontario Building Inspector and/or local Fire Department Provide two-way radio communication at each annunciator, control point and other areas in the building as required. All testing must be witnessed by 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 Consultant for review including letter of certification from the manufacturer(s).
  - .4 Witness of complete system by Consultant and/or his representatives.

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**FIRE ALARM SYSTEM**

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- .5 Correction of any deficiencies noted.
- .6 Acceptance of the system by the Consultant.
- .7 Witness of system test by authority having jurisdiction.
- .8 Correction of any deficiencies requested by 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 of training. Schedule training with the Owner a minimum of seven Days in advance.

**END OF SECTION**